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(54) Title: ONCOLYTIC COMBINATIONS FOR THE TREATMENT OF CANCER

(57) Abstract: Leukotriene (LTB_4) antagonists enhance the effectiveness of 2',2'-difluoronucleoside anti-cancer agents.

ONCOLYTIC COMBINATIONS FOR THE TREATMENT OF CANCER

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority from United States Provisional Patent Application No. 60/164,786 filed 11 November 1999; the entire disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

This invention relates to a method of treating cancer with anti-cancer agents. More specifically, it relates to the use of 2',2'-difluoronucleoside anti-cancer agents, in conjunction with leukotriene (LTB_4) antagonists which enhance the effectiveness of the anti-cancer agent.

BACKGROUND OF THE INVENTION

Leukotriene B_4 (LTB_4) is a proinflammatory lipid which has been implicated in the pathogenesis of psoriasis, arthritis, chronic lung diseases, acute respiratory distress syndrome, shock, asthma, inflammatory bone diseases and other inflammatory states characterized by the infiltration and activation of polymorphonuclear leukocytes and other proinflammatory cells. Thus activated, the polymorphonuclear leukocytes liberate tissue-degrading enzymes and reactive chemicals causing the inflammation. US Patent 5,462,954 discloses phenylphenol leukotriene antagonists that are useful in

the treatment of psoriasis, arthritis, chronic lung diseases, acute respiratory distress syndrome, shock, asthma, inflammatory bone diseases and other inflammatory states characterized by the infiltration and activation of polymorphonuclear leukocytes and other proinflammatory cells. US Patent 5,910,505 discloses that certain phenylphenol leukotriene B_4 (LTB_4) antagonists are useful as agents for the treatment of oral squamous cell carcinoma. US Patent 5,543,428 discloses a group of phenylphenol leukotriene antagonists which have the property of reversing multi drug resistance in tumor cells. The use of the leukotriene antagonist will reverse the drug resistance of resistant tumor cells to vinblasine, vincristine, vindesine, navelbine, daunorubicin, doxorubicin, mitoxantrone, etoposide, teniposide, mitomycin C, actinomycin, taxol, topotecan, mithramycin, colchicine, puromycin, podophylotoxin, emetine, gramicidin, and valinomycin.

BRIEF SUMMARY OF THE INVENTION

This invention provides compositions and methods useful for treating cancers, in particular, cancers that are not multi drug resistant. The methods of the present invention include the 2',2'-difluoronucleoside anti-cancer agents described in US Patent 5,464,826 in combination with leukotriene (LTB_4) antagonists of formula A, formula I and formula II, described below.

Surprisingly, we have found that the combination of 2',2'-difluoro nucleoside anti-cancer agents with

leukotriene (LTB_4) antagonists act synergistically against cancers which are not multi-drug resistant.

The types of cancers that may be treated with the compositions of the present invention include: Breast Carcinoma, Bladder Carcinoma, Colorectal Carcinoma, Esophageal Carcinoma, Gastric Carcinoma, Germ Cell Carcinoma e.g. Testicular Cancer, Gynecologic Carcinoma, Lymphoma Hodgkin's, Lymphoma - Non-Hodgkin's, Malignant Melanoma, Multiple Myeloma, Neurologic Carcinoma, Brain Cancer, Pancreatic Carcinoma, Prostate Carcinoma, Ewings Sarcoma, Osteosarcoma, Soft Tissue Sarcoma, Non-Small Cell Lung Cancer, Pediatric Malignancies and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 through 6 are horizontal bar graphs displaying the data of Tables 1 through 6 provided in the "ASSAY EXAMPLE 1", infra. The vertical axis of the graph in each Figure forms the origin of the numbered horizontal bars, wherein each bar is a separate Treatment as set out in the Tables. The horizontal axis is tumor growth delay (TGD) in days.

DETAILED DESCRIPTION OF THE INVENTION

I. Definitions:

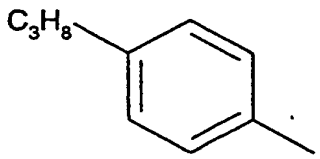
The term, "Acidic Group" means an organic group which when attached as the "Z" substituent of formula (I) or the "Z2" substituent of formula (II) acts as a proton donor capable of hydrogen bonding. An illustrative acidic group is carboxyl.

The term, "Active Ingredient" refers both to certain 2', 2'-difluoronucleoside compounds and also leukotriene B4 antagonist compounds generically described by formula A as well as diphenyl leukotriene B_4 antagonist compounds generically described by formula I and formula II or the list of specific diphenyl compounds disclosed, infra., as well as a combination of a 2', 2'-difluoronucleoside and a leukotriene B4 antagonist described by formula A or formulas I and/or II, and the salts, solvates, and prodrugs of such compounds.

The term, "alkenyl" means a monovalent radical of the generic formula C_nH_{2n} such as ethenyl, n-propenyl, isopropeneyl, n-butenyl, isobutenyl, 2-butenyl, and 3-butenyl.

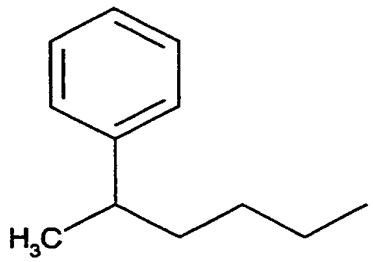
The term, "alkyl" by itself or as part of another substituent means, unless otherwise defined, a straight or branched chain monovalent hydrocarbon radical such as methyl, ethyl, n-propyl, isopropyl, n-butyl, tertiary butyl, sec-butyl, n-pentyl, and n-hexyl.

The term, "alkaryl" means an aryl radical substituted with an alkyl or substituted aryl group, for example:



In the term, "C_6-C_{20} alkaryl" the numerical subscripts refer to the total number of carbon atoms in the radical.

The term, "C_6-C_{20} aralkyl" means an alkyl radical substituted with an aryl or substituted aryl group, for example:



In the term, "C_6-C_{20} aralkyl" the numerical subscripts refer to the total number of carbon atoms in the radical.

The term, "carbocyclic group" refers to a five, six, seven, or eight membered saturated, unsaturated or aromatic ring containing only carbon and hydrogen (e.g., benzene, cyclohexene, cyclohexane, cyclopentane).

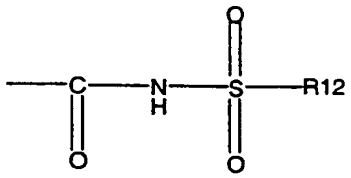
The term, "cycloalkyl" means a carbocyclic non-aromatic monovalent radical such as cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, and cyclooctyl.

The term, "halo" means fluoro, chloro, bromo, or iodo.

The term, "heterocyclic radical(s)" refers to a radical having a saturated, unsaturated or aromatic five membered substituted or unsubstituted ring containing from 1 to 4 hetero atoms.

The terms, "mammal" and "mammalian" include human.

The term, "N-sulfonamidyl" means the radical:

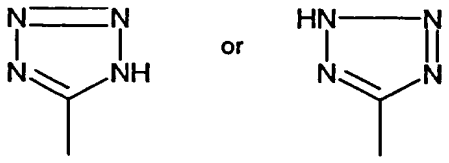


where R12 is C_1-C_{10} alkyl, aryl, C1-C6 alkyl substituted aryl, C_6-C_{20} alkaryl, or C_6-C_{20} aralkyl.

The term, "substituted alkyl" means an alkyl group further substituted with one or more radical(s) selected from halo, C_1-C_6 alkyl, aryl, benzyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_3-C_8 cycloalkyl, C_1-C_8 alkoxy, C_1-C_6 haloalkyl (e.g., $-CF_3$).

The term, "substituted aryl" means an aryl group further substituted with one or more radical(s) selected from halo, C_1-C_6 alkyl, aryl, benzyl, C_2-C_6 alkenyl, C_2-C_6 alkynyl, C_3-C_8 cycloalkyl, C_1-C_8 alkoxy, C_1-C_6 haloalkyl (e.g., $-CF_3$).

The term, "tetrazolyl" refers to an acidic group represented by either of the formulae:

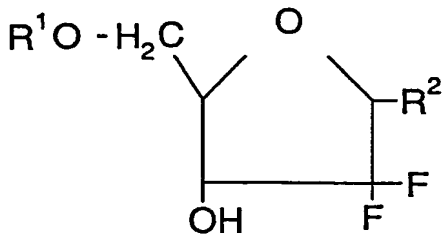


The term "therapeutically effective interval" is a period of time beginning when one of either (a) the 2', 2'-difluoronuceoside anti-cancer agent or (b) the LTB_4 antagonist is administered to a mammal and ending at the

limit of the anti-cancer beneficial effect in treating cancer of (a) or (b). Typically, the anti-cancer agents and the leukotriene (LTB_4) antagonist are administered within 24 hours of each other, more preferably within 4 hours and most preferably within 1 hour.

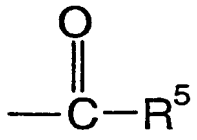
The phrase "therapeutically effective combination", used in the practice of this invention, means administration of both (a) the 2', 2'-difluoronuceoside anti-cancer agent and (b) the LTB_4 antagonist, either simultaneously or separately, in any order.

The anti cancer agents which may be used are 2',2'-difluoronucleoside compounds of the formula:

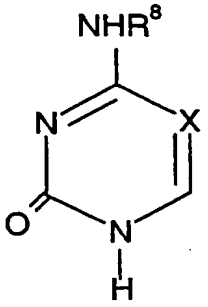


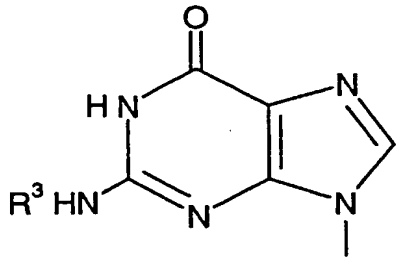
wherein:

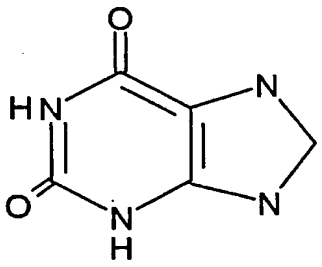
R^2 is hydrogen or

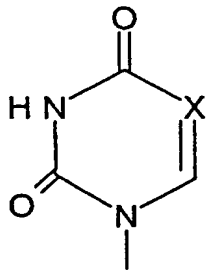


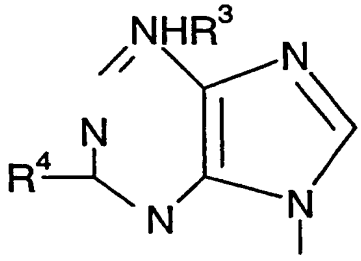
R^2 is a base defined by one of the formulae





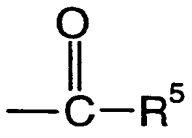






X is N or C-R^4

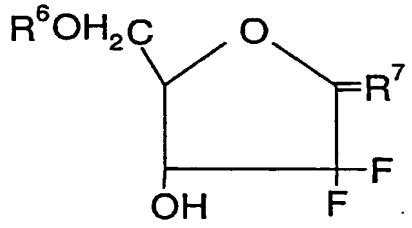
R^3 is hydrogen, C_1-C_4 alkyl or



R^4 is hydrogen, C_1-C_4 alkyl, amino, bromo, fluoro, chloro or iodo;

Each R^5 independently is hydrogen or C_1-C_4 alkyl; and the pharmaceutically-acceptable salts thereof.

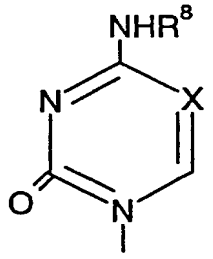
The following compounds may also be used

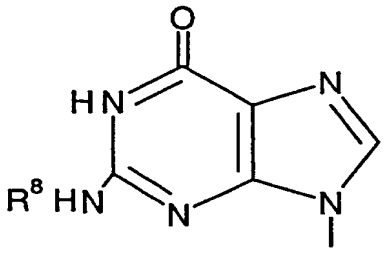


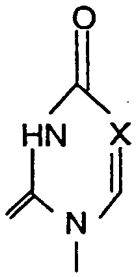
wherein:

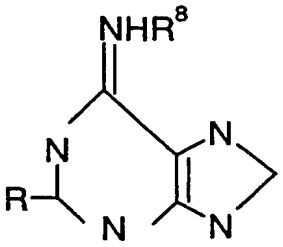
R^6 is hydrogen, C_1-C_4 alkyl;

R^7 is a base of one of the formulae





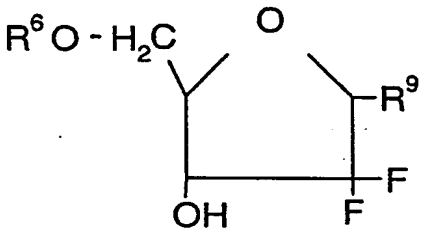




X is N or C-R^4;

R^8 is hydrogen or C_1-C_4 alkyl;

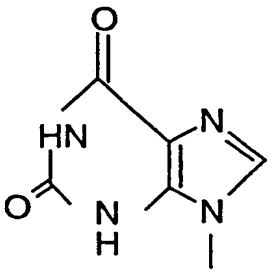
R^4 is hydrogen, C_1-C_4 alkyl; amino, bromo, fluoro, chloro and iodo; and the pharmaceutically-acceptable salts thereof; with the proviso that R^6 and R^8 may both be hydrogen only when X is N and



wherein:

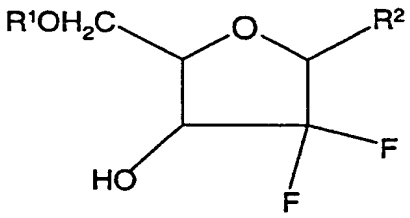
R^6 is hydrogen or C_1-C_4 alkyl;

R^9 is



These compounds are disclosed in US Patent 5,464,826 which is incorporated by reference herein for its disclosure of the methods of preparing these compounds, formulating these compounds, and the treatment of cancer using these compounds.

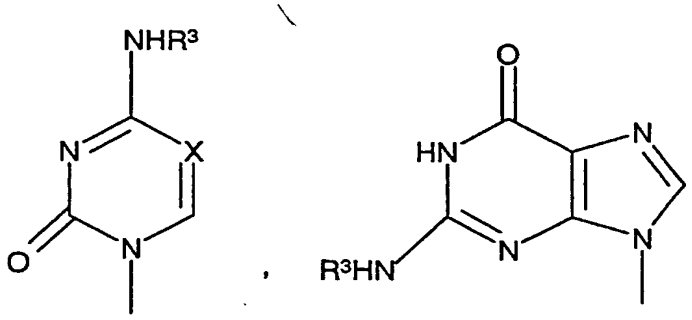
Alternatively, preferred 2'2'-difluoronucleoside compounds are compounds represented by the formula:

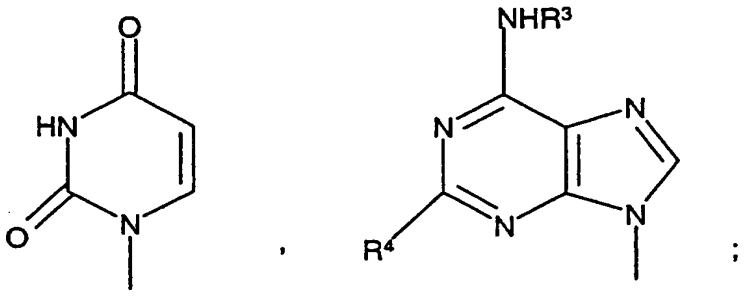


where:

R^1 is hydrogen;

R^2 is a base defined by one of the formulae:





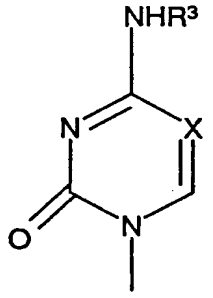
X is C-R^4;

R^3 is hydrogen;

R^4 is hydrogen, C_1-C_4 alkyl, bromo, fluoro, chloro or iodo;

and pharmaceutically acceptable salts thereof.

More preferably the compounds are whereR^2 is the base defined by the formula:



Even more preferred are anti-cancer agents are selected from the group consisting of the following compounds or a pharmaceutically acceptable salt thereof:

(i) 1-(4-amino-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluororibose,

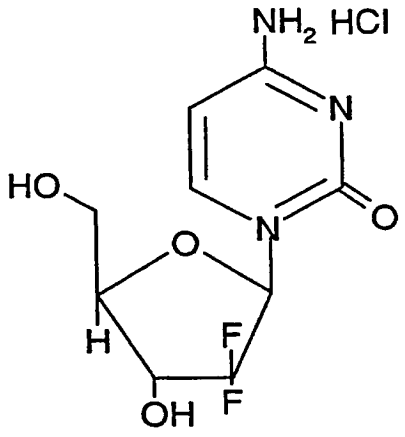
(ii) 1-(4-amino-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluoroxylose,

(iii) 1-(2,4-dioxo-1H,3H-pyrimidin-1-yl)-2-desoxy-2',2'-difluororibose, and

(iv) 1-(4-amino-5-methyl-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluororibose.

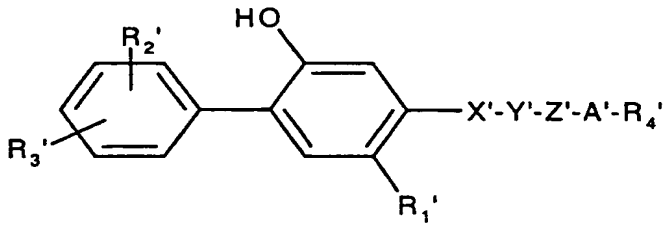
The most preferred compound is gemcitabine HCl which is a nucleoside analogue that exhibits antitumor activity. Gemcitabine HCl is 2'-deoxy-2',2'-difluorocytidine monohydrochloride (β-isomer), also known as 2',2'-difluoro-2'-deoxycytidine monohydrochloride, or also as 1-(4-amino-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluororibose.

The structural formula is as follows:



The anti-cancer agents are generally mixed with a carrier which may act as a diluent, or excipient the anti-cancer agents may be administered in the form of tablets, pills, powders lozenges, sachets, cachets, elixirs, suspensions, emulsion, solution, syrups or aerosols. Sterile injectable solutions may also be used.

The leukotriene (LTB_4) antagonists useful in the present invention include those given in formula A.



Formula A

or a pharmaceutically acceptable base addition salt thereof, wherein:

R_1' is C_1-C_5 alkyl, C_2-C_5 alkenyl, C_2-C_5 alkynyl, C_1-C_4 alkoxy, (C_1-C_4 alkyl)thio, halo, or R_2'-substituted phenyl;

each R_2' and R_3' are each independently hydrogen, halo, hydroxy, C_1-C_4 alkyl, C_1-C_4 alkoxy, (C_1-C_4 alkyl)-$(O)_q$ S-, trifluoromethyl, or di-(C_1-C_3 alkyl)amino;

X' is -O-, -S-, -C(=O), or $-CH_2-$;

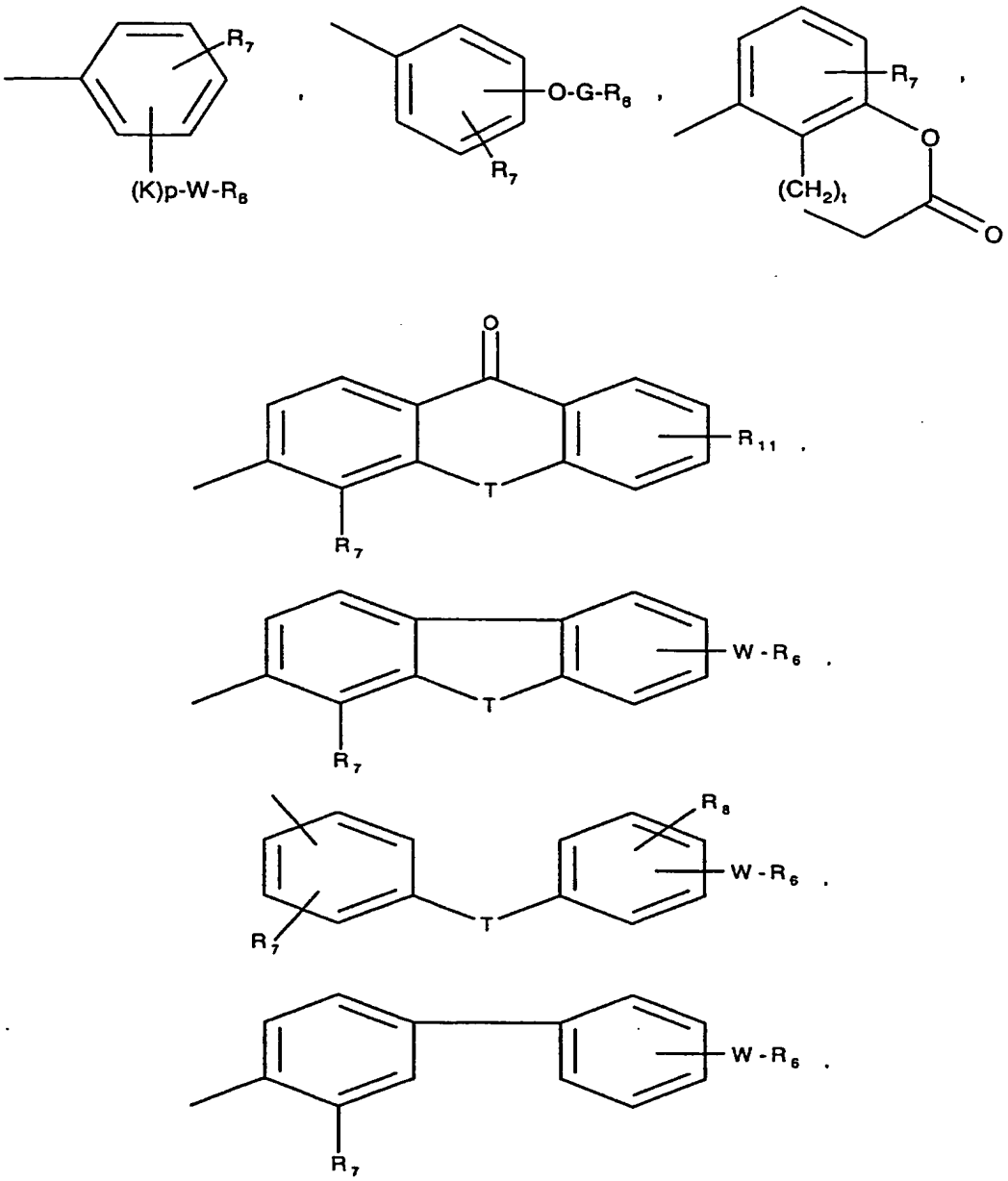
Y' is -O- or $-CH_2-$;

or when taken together, -X'-Y'- is -CH=CH- or -C≡C-;

Z' is a straight or branched chain C_1-C_{10} alkylidenyl;

A' is a bond, -O-, -S-, -CH=CH-, or $-CR_aR_b-$, where R_a and R_b are each independently hydrogen, C_1-C_5 alkyl, or R_7'-substituted phenyl, or when taken together with the carbon atom to which they are attached form a C_4-C_8 cycloalkyl ring;

R_4' is R_6



where

each R_6 is independently -COOH, 5-tetrazolyl, -$CON(R_9)_2$, or -$CONHSO_2R_{10}$;

each R_7 is hydrogen, C_1-C_4 alkyl, C_2-C_5 alkenyl, C_2-C_5 alkynyl, benzyl, methoxy, -W-R_6, -T-G-R_6, (C_1-C_4 alkyl)-T-(C_1-C_4 alkylidenyl)-O-, or hydroxy;

R_8 is hydrogen or halo;

each R_9 is independently hydrogen, phenyl, or C_1-C_4 alkyl, or when taken together with the nitrogen atom form a morpholino, piperidino, piperazino, or pyrrolidino group;

R_{10} is C_1-C_4 alkyl or phenyl;

R_{11} is R_2, -W-R_6, or -T-G-R_6;

each W is a bond or a straight or branched chain divalent hydrocarbyl radical of one to eight carbon atoms;

each G is a straight or branched chain divalent hydrocarbyl radical of one to eight carbon atoms;

each T is a bond, -CH_2-, -O-, -NH-, -NHCO-, -C(=O)-, or $(O)_q$ S-;

K is -C(=O)- or -CH(OH)-;

each q is independently 0, 1, or 2;

p is 0 or 1; and

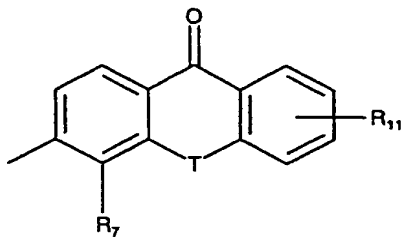
t is 0 or 1;

provided when X is -O- or -S-, Y is not -O-;

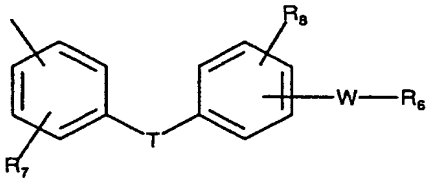
provided when A is -O- or -S-, R_4' is not R_6;

and provided W is not a bond when p is 0.

Preferred LTB_4 antagonists of Formula A are those compounds wherein R_4' is selected from the following formulae:

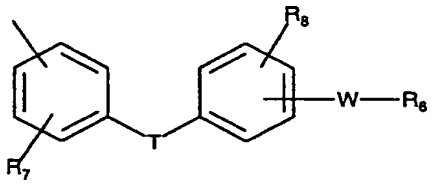


, or



.

An even more preferred LTB_4 antagonist of Formula A are those compounds wherein R_4' is:



.

Some of these preferred LTB_4 antagonist compounds or pharmaceutically acceptable acid or salt derivatives thereof are listed herein from the group (A) to (KKKK) consisting of:

A) 2-Methyl-2-(1H-tetrazol-5-yl)-7-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)heptane;

B) 2-Methyl-2-(1H-tetrazol-5-yl)-7-(2-ethyl-4-(3-fluorophenyl)-5-hydroxyphenoxy)heptane;

C) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-dimethylaminocarbonylbutyloxy)phenyl)propionic acid;

D) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionic acid;

E) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-carboxybutyloxy)phenyl)propionic acid;

F) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-methoxyphenyl)propionic acid;

G) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-(1H-tetrazol-5-yl)butyloxy)phenyl)propionic acid;

H) Methyl 3-(2-(4-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)-(1-butenyl))phenyl)propionate;

I) 3-(2-(4-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)-(1-butenyl))phenyl)propionic acid;

J) 3-(2-(4-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)butyl)phenyl)propionic acid;

K) 3-(2-(4-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)butyl)-6-methoxyphenyl)propionic acid;

L) Methyl 3-(2-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-hydroxyphenyl)propionate;

M) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-hydroxyphenyl)propionic acid;

N) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-butyloxy)phenyl)propionic acid;

O) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-methylthiobutyloxy)phenyl)propionic acid;

P) 3-(2-(3-(2,4-Di(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-carboxybutoxy)phenyl)propionic acid;

Q) 6-Methyl-6-(1H-tetrazol-5-yl)-11-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)undecane;

R) N,N-Dimethyl-3-(2-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionamide;

S) N-Methanesulfonyl-3-(2-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionamide;

T) N-Phenylsulfonyl-3-(2-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionamide;

U) 3-(2-(3-(2-Butyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionic acid;

V) Ethyl 3-(2-(4-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)butyloxy)phenyl)propionate;

W) 3-(2-(4-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)butyloxy)phenyl)propionic acid;

X) Methyl 3-(2-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-(methoxycarbonyl)phenoxy)phenyl)propionate;

Y) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-carboxyphenoxy)phenyl)propionic acid;

Z) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-4-(4-carboxyphenoxy)phenyl)propionic acid;

AA) 3,3-Dimethyl-3-(2-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionic acid;

BB) 2-Methyl-2-(1H-tetrazol-5-yl)-3-(2-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propane;

CC) 2-Methyl-2-(1H-tetrazol-5-yl)-3-hydroxy-3-(2-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propane;

DD) 3-(2-(3-(2-Bromo-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionic acid;

EE) 3-(2-(3-(2-Ethylthio-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionic acid;

FF) Methyl 3-(2-hydroxy-3-(4-methoxycarbonylbutyl)-6-(3-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)propionate;

GG) 5-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-8-(4-carboxybutyl)dihydrocoumarin;

HH) 2-Phenyl-4-ethyl-5-[6-(2H-tetrazol-5-yl)-6-methylheptyloxy]phenol sodium salt;

II) 2-(4-Methylphenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol disodium salt;

JJ) 2-(3-Methylphenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol sodium salt;

KK) 2-(2-Methylphenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol disodium salt;

LL) 2-(4-Methoxyphenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol sodium salt;

MM) 2-(3-Methoxyphenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol sodium salt;

NN) 2-(4-Trifluoromethylphenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol disodium salt;

OO) 2-(3-Dimethylaminophenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol disodium salt;

PP) 3-(5-(6-(4-Phenyl-5-hydroxy-2-ethylphenoxy)propoxy)-2-carboxymethyl-1,2,3,4 -tetrahydronaphthalen-1(2H)-one)propanoic acid;

QQ) 3-(5-(6-(4-(4-Fluorophenyl)-5-hydroxy-2-ethylphenoxy)propoxy)-2-carboxymeth yl-1,2,3,4-tetrahydronaphthalen-1(2H)-one)propanoic acid;

RR) 3-(4-(5-(4-(4-Fluorophenyl)-5-hydroxy-2-ethylphenoxy)propoxy)-2-carboxymeth yl-2,3-dihydroinden-1(2H)-one)propanoic acid;

SS) 3,3-Dimethyl-5-(3-(2-carboxyethyl)-4-(3-(4-fluorophenyl)-5-hydroxy-2-ethylphenoxy)propoxy)phenyl)-5-oxopentanoic acid;

TT) 7-[3-[(5-Ethyl-2-hydroxy[1,1'-biphenyl]-4-yl)oxy]propoxy]-3,4-dihydro-8-propyl-2H-1-benzopyran-2-carboxylic acid;

UU) 8-Propyl-7-[3-[4-(4-fluorophenyl)-2-ethyl-5-hydroxyphenoxy]propoxy]-3,4-dihydro-2H-1-benzopyran-2-carboxylic acid;

VV) 2-[3-[3-[(5-Ethyl-2-hydroxy[1,1'-biphenyl]-4-yl)oxy]propoxy]-2-propylphenoxy]propanoic acid;

WW) 2-(4-Chlorophenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol monosodium salt;

XX) 2-(3,5-Dichlorophenyl)-4-ethyl-5-[6-methyl-6-(2H-tetrazol-5-yl)heptyloxy]phenol monosodium salt;

YY) 3-[2-[3-[(5-Ethyl-2-hydroxy[1,1'-biphenyl]-4-yl)oxy]propoxy]-1-dibenzofuran]propanoic acid disodium salt;

ZZ) 7-Carboxy-9-oxo-3-[3-(2-ethyl-5-hydroxy-4-phenylphenoxy)propoxy]-9H-xanthene-4-propanoic acid disodium salt monohydrate;

AAA) 2-[2-Propyl-3-[3-(2-ethyl-5-hydroxy-4-phenylphenoxy)propoxy]phenoxy]benzoic acid sodium salt hemihydrate;

BBB) 3-[3-(2-Ethyl-5-hydroxy-4-phenylphenoxy)propoxy][1,1'-biphenyl]-4-propanoic acid disodium salt monohydrate;

CCC) 5-Ethyl-4-[3-[2-propyl-3-[2-(2H-tetrazol-5-yl)phenoxy]phenoxy]propoxy][1,1'-biphenyl]-2-ol disodium salt sesquihydrate;

DDD) 3-[4-[3-[3-(2-Ethyl-5-hydroxy-4-phenylphenoxy)propoxy]-9-oxo-9H-xanthene]]propanoic acid sodium salt hemihydrate;

EEE) 2-Fluoro-6-[2-propyl-3-[3-(2-ethyl-5-hydroxy-4-phenylphenoxy)propoxy]phenoxy]benzoic acid disodium salt;

FFF) 2-[2-Propyl-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]phenoxy]benzoic acid sodium salt;

GGG) 3-[4-[7-Carboxy-9-oxo-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]-9H-xanthene]] propanoic acid disodium salt trihydrate;

HHH) 3-[4-[9-Oxo-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]-9H-xanthene]]propanoic acid;

III) 3-[2-[1-[2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]-4-(5-oxo-5-morpholinopentanamido)phenyl]propanoic acid;

JJJ) 2-Fluoro-6-[2-propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]benzoic acid disodium salt hydrate;

KKK) 4-Fluoro-2-[2-propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]benzoic acid;

LLL) 2-[2-Propyl-3-[5-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]pentoxy]phenoxy]benzoic acid;

MMM) 2-[2-Propyl-3-[4-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]butoxy]phenoxy]benzoic acid sesquihydrate;

NNN) 2-[2-(2-Methylpropyl)-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]benzoic acid;

OOO) 2-[2-Butyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]benzoic acid hydrate;

PPP) 2-[2-(Phenylmethyl)-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]benzoic acid;

QQQ) 2-[2-Propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]phenylacetic acid;

RRR) 2-[2-Propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]benzoyl]benzoic acid;

SSS) 2-[[2-Propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenyl]methyl]benzoic acid;

TTT) 2-[2-Propyl-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]thiophenoxy]benzoic acid;

UUU) 2-[2-Propyl-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]phenylsulfinyl]benzoic acid;

VVV) 2-[2-Propyl-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]phenylsulfonyl]benzoic acid hydrate;

WWW) 5-[3-[2-(1-Carboxy)ethyl]-4-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]phenyl]-4-pentynoic acid disodium salt 0.4 hydrate;

XXX) 1-Phenyl-1-(1H-tetrazol-5-yl)-6-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)hexane;

YYY) 1-(4-(Carboxymethoxy)phenyl)-1-(1H-tetrazol-5-yl)-6-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)hexane;

ZZZ) 1-(4-(Dimethylaminocarbonylmethoxy)phenyl)-1-(1H-tetrazol-5-yl)-6-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)hexane;

AAAA) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)-E-propenoic acid;

BBBB) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)-2-methyl-E-propenoic acid;

CCCC) 5-(2-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)phenyl)ethyl)-1H-tetrazole;

DDDD) 3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-4-(4-carboxybutyloxy)phenyl)propionic acid;

EEEE) 5-[3-[4-(4-Fluorophenyl)-2-ethyl-5-hydroxyphenoxy]propoxy]-3,4-dihydro-2H-1-benzopyran-2-one;

FFFF) 3-(3-{3-[2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenyloxy]propoxy}phenyl)propanoic acid;

GGGG) 3-(3-{3-[2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenyloxy]propoxy}-4-propylphenyl)propanoic acid sodium salt;

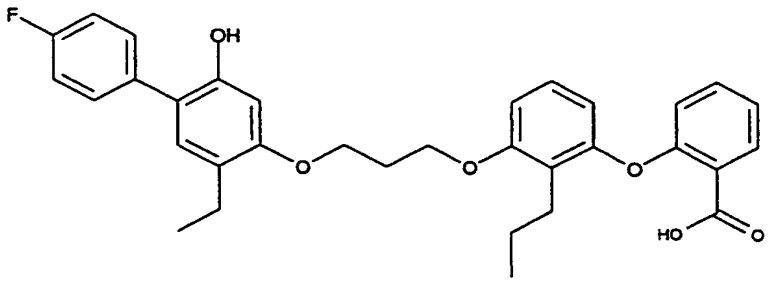
HHHH) 3-(4-{3-[2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenyloxy]propoxy}-3-propylphenyl)propanoic acid;

IIII) 3-(3-{3-[2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenyloxy]propoxy}-2-propylphenyl)propanoic acid;

JJJJ) 3-{3-[3-(2-Ethyl-5-hydroxyphenyloxy)propoxy]-2-propylphenyl}propanoic acid disodium salt; and

KKKK) 2-[3-[3-[2-Ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]benzoyl]benzoic acid disodium salt hemihydrate.

These leukotriene (LTB_4) antagonists are well known in the art, and are fully described in U.S. Patent 5,462,954, which is hereby specifically incorporated by reference for its disclosure of the methods of preparation of specific leukotriene B_4 antagonists and compounds or formulations of the leukotriene antagonists which may be administered to patients. A preferred compound is 2-[2-propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-flourophenyl)phenoxy]propoxy]phenoxy benzoic acid which can also be named 2-[3-[3-(5-ethyl-4'-flouro-2-hydroxybiphen-4-yloxy)propoxy-2-propylphenoxy]benzoic acid, described in U.S. Patent 5,462,954 as example 66 and also shown below as Compound A (Formula B):

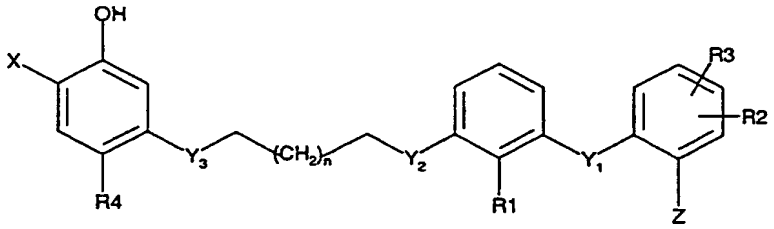


Compound A (Formula B)

A second class of LTB_4 antagonists to use as the essential co-agent in the compositions and practice of the method of this invention are those disclosed in copending provisional patent application, titled, "Heterocycle Substituted Diphenyl Leukotriene Antagonists" (inventor, Jason Scott Sawyer) containing 97 pages and identified as Eli Lilly and Company Docket No. B-13240), filed on November 11, 1999, and now Provisional patent Application Serial Number 60/164,786. This second class of heterocycle substituted diphenyl leukotriene antagonists are described in more detail below:

II. Additional LTB_4 Antagonists:

Additional LTB_4 antagonists are described below which are novel heterocyclic substituted diphenyl compounds of formula (I)



(I)

wherein:

X is selected from the group consisting of,

(i) a five membered substituted or unsubstituted heterocyclic radical containing from 1 to 4 hetero atoms independently selected from sulfur, nitrogen or oxygen; or

(ii) a fused bicyclic radical wherein a carbocyclic group is fused to two adjacent carbon atoms of the five membered heterocyclic radical, (i);

Y_1 is a bond or divalent linking group containing 1 to 9 atoms;

Y_2 and Y_3 are divalent linking groups independently selected from $-CH_2-$, $-O-$, and $-S-$;

Z is an Acidic Group;

R1 is C_1-C_{10} alkyl, aryl, C_3-C_{10} cycloalkyl, C_2-C_{10} alkenyl, C_2-C_{10} alkynyl, C_6-C_{20} aralkyl, C_6-C_{20} alkaryl, C_1-C_{10} haloalkyl, C_6-C_{20} aryloxy, or C_1-C_{10} alkoxy;

R2 is hydrogen, halogen, C_1-C_{10} haloalkyl, C_1-C_{10} alkoxy, C_1-C_{10} alkyl, C_3-C_8 cycloalkyl, Acidic Group, or $-(CH_2)_{1-7}$(Acidic Group);

R3 is hydrogen, halogen, C_1-C_{10} alkyl, aryl, C_1-C_{10} haloalkyl, C_1-C_{10} alkoxy, C_1-C_{10} aryloxy, C_3-C_8 cycloalkyl;

R4 is C_1-C_4 alkyl, C_3-C_4 cycloalkyl, $-(CH_2)_{1-7}$(cycloalkyl), C_2-C_4 alkenyl, C_2-C_4 alkynyl, benzyl, or aryl; and

n is 0, 1, 2, 3, 4, 5, or 6;

or a pharmaceutically acceptable salt, solvate, or prodrug derivative thereof.

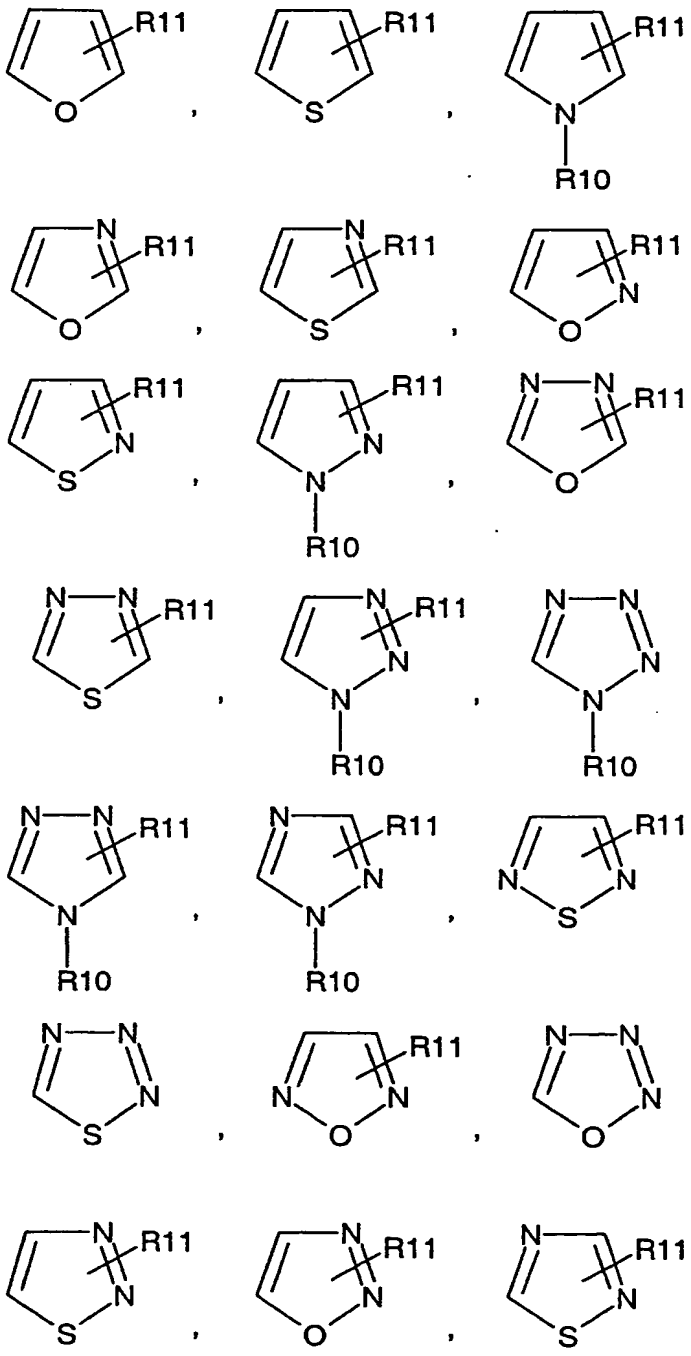
III. Preferred LTB_4 Antagonists include the following:

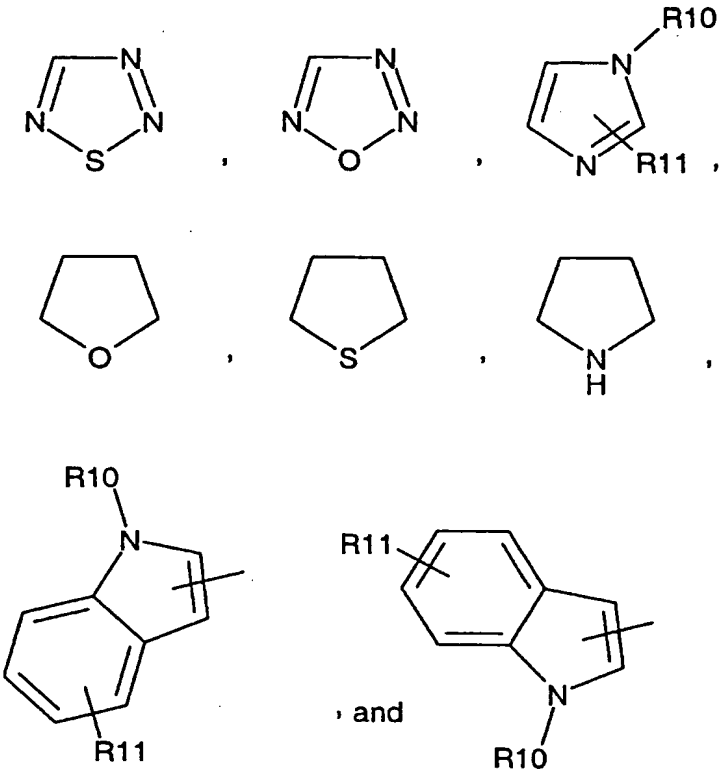
III A. Preferred X substituents:

A "substituted heterocyclic radical" is preferably substituted with from 1 to 3 groups independently selected from hydrogen, halo, C_1-C_{10} alkyl, C_1-C_{10} haloalkyl, C_1-C_{10} alkoxy, aryl, or C_6-C_{20} aryloxy.

Preferred Group 1 of X substituent (symbol, "PG1-X")

Preferred LTB_4 antagonist compounds used in the composition of the invention are those wherein X is a heterocyclic radical selected from the group consisting of substituents represented by the following structural formulae:


R11
O
S
N
R10



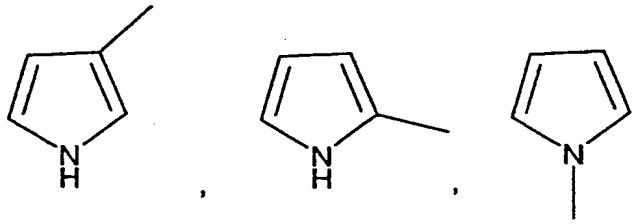
;

where R10 is a radical selected from hydrogen or C_1-C_4 alkyl; and R11 is a radical selected from hydrogen, halo, C_1-C_{10} alkyl, C_1-C_{10} haloalkyl, C_1-C_{10} alkoxy, aryl, or C_6-C_{20} aryloxy. Preferred R10 groups are hydrogen, methyl, or phenyl. Moreover, any of the above heterocyclic radicals illustrated by structural formulae may attach to the diphenyl leukotriene antagonist of formulae (I) by any monovalent bond originating on a suitable carbon or nitrogen atom in its ring structure.

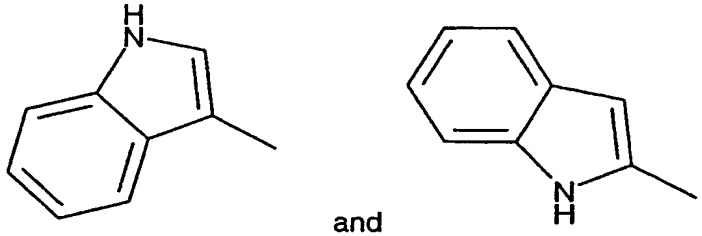
For example, the pyrrole radical may attach to the diphenyl molecule by a single bond originating at any carbon

atom or any nitrogen atom which has less than three bonds in the heterocyclic ring;

Location of attachment bond for pyrrole,



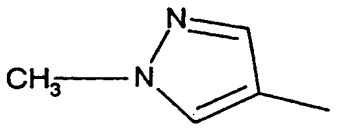
A preferred form of the substituent X is a fused bicyclic radical wherein a carbocyclic group is fused to two adjacent carbon atoms of the five membered heterocyclic radical, for example:



and

III B. Preferred Group 2 of X substituent (symbol, "PG2-X"):

Most preferred as the X substituents are the heterocyclic radicals;



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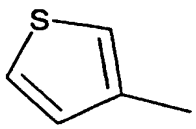

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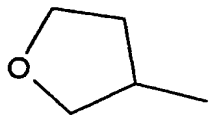

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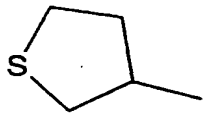


III C. Excluded X substituents:

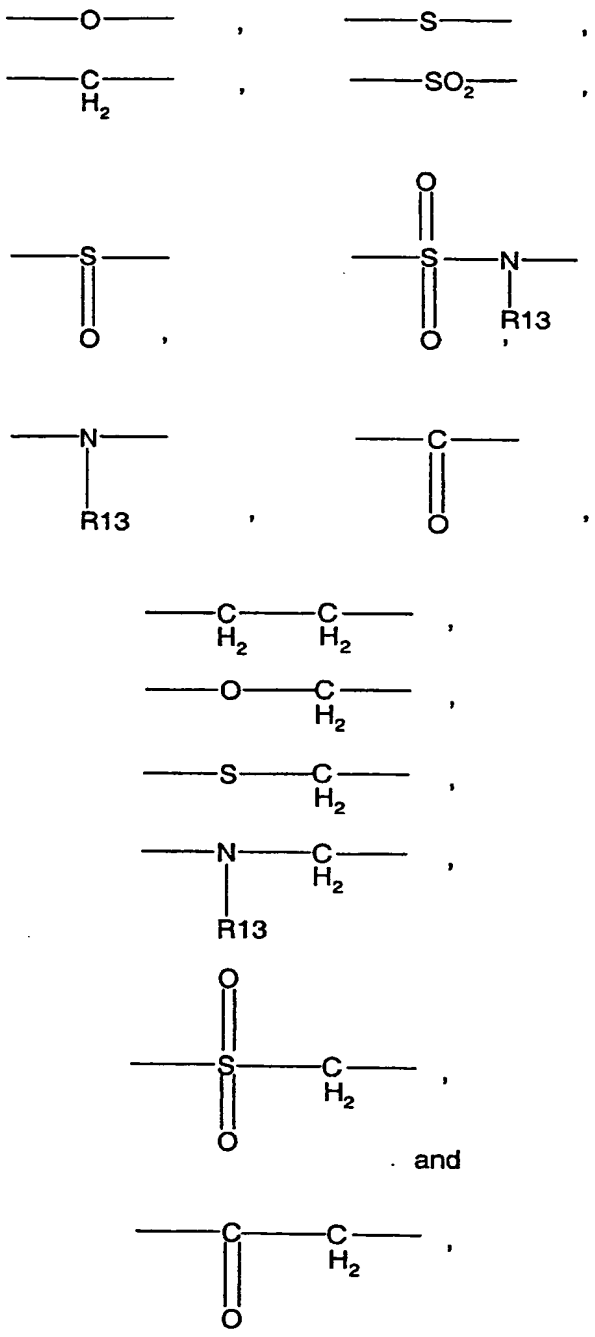
The heterocyclic radical X of Formula (I) does not include 3-bromo-1,2,4 thiadiazole since the LTB_4 antagonist activity of compounds containing this radical is considered too low to be an aspect of this invention.

III D. Preferred Y_1 substituents:

Y_1 is a bond or divalent linking group containing 1 to 9 atoms independently selected from carbon, hydrogen, sulfur, nitrogen, and oxygen;

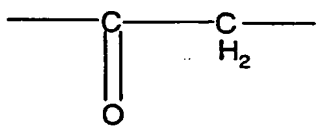
Preferred Group 1 of Y_1 substituent (symbol, "PG1-Y_1")

Preferred LTB_4 compounds included in the composition of the invention are those wherein Y_1 is a divalent linking group selected from the group consisting of substituents represented by the following formulae:

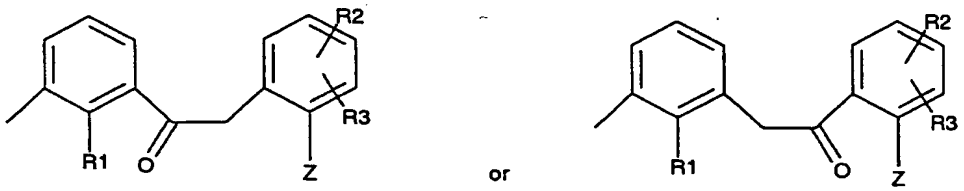


where R13 is hydrogen, methyl, or ethyl;

The above divalent groups may be used in their forward or reversed positions. For example, the group;



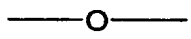
may be positioned as either,



in the displayed fragment of formula (I).

III E. Preferred Group 2 of Y_1 substituent (symbol, "PG2-Y_1"):

The most preferred divalent Y_1 substituent is the group;

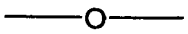


III F. Preferred Group 1 of Y_2 substituent (symbol, "PG1-Y_2") and Preferred Group 1 of Y_3 substituent (symbol, "PG1-Y_3"):

The Y_2 and Y_3 substituents are preferably selected from -S- and -O-.

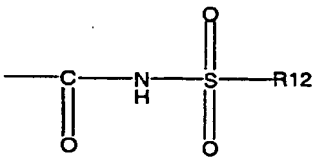
III G. Preferred Group 2 of Y_2 substituent (symbol, "PG2-Y_2") and Preferred Group 2 of Y_3 substituent (symbol, "PG2-Y_3"):

Most preferably both Y_2 and Y_3 are the group;



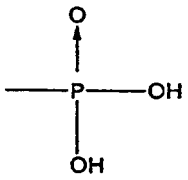
III H. Preferred Group 1 of Z substituent (symbol, "PG1-Z"):

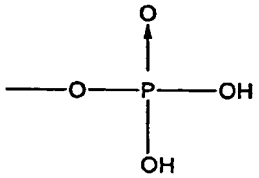
Z is the Acidic Group as previously defined. Preferred is an acidic group selected from the following:

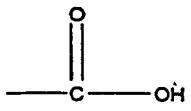


tetrazolyl,

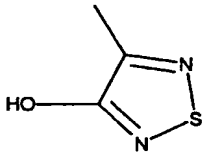
$-SO_3H$,



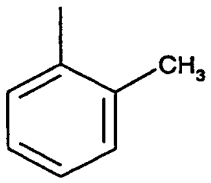




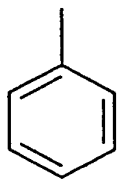
or



where R12 is C_1-C_{10} alkyl, aryl, C_6-C_{20} alkaryl, or C_6-C_{20} aralkyl. Preferred R12 groups are represented by the formulae:



and



III I. Preferred Group 2 of Z substituent (symbol, "PG2-Z"):

Highly preferred are the acidic groups; -5-tetrazolyl,

N-acyl sulfonamide, $-SO_3H$, and carboxyl.

III J. Preferred Group 3 of Z substituent (symbol, "PG3-Z"):

Carboxyl is the most preferred Z substituent.

III K. Preferred Group 1 of n subscript variable (symbol, "PG1-n")

The most preferred integer values for the divalent linking group, $-(CH_2)_n-$, are n=1, n=2, and n=3.

III L. Preferred Group 2 of n subscript variable (symbol, "PG2-n")

The most preferred integer value of n for the divalent linking group, $-(CH_2)_n-$ is n = 1.

III M. Preferred Group 1 of R1 substituent (symbol, "PG1-R1"):

A preferred R1 group is methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, and 2-propenyl; with n-propyl being most preferred.

III N. Preferred Group 1 of R2 substituent (symbol, "PG1-R2")and Preferred Group 1 of R3 substituent (symbol, "PG1-R3"):

Preferred R2 and R3 groups are those wherein R2 and R3 are independently selected from hydrogen or methyl, ethyl, methoxy, ethoxy, halo, or $-CF_3$; with R2 and R3 both being hydrogen as most preferred.

III O. Preferred Group 1 of R4 substituent (symbol, "PG1-R4":)

Preferred R4 substituents are ethyl, propyl, and isopropyl.

III P. Combinations of substituents of the compound of Formula (I):

The substituents of formula (I) are defined as "Z", "X", "n", "R1", "R2", "R3", "R4", "Y1", "Y2", and "Y3". Moreover, as described in the preceding section, within

each of the defined substituents of Formula (I) are "preferred" and "most preferred" subgroups which define the variety of substituents to be used in the definition of LTB_4 antagonists of the invention. These preferred subgroups are defined by designations such as "PG1-R4" as recited above. It is often advantageous to use combinations of preferred groups or combinations of preferred groups together with the general definition of variables given in Formula (I). Suitable combinations of substituents are shown in the following three Tables (viz., R-Table, Y-Table & XZn-Table).

The following R-Table is used to select combinations of general and preferred groupings of the variables R1, R2, R3 and R4 for substitution in formula (I), as follows:

R-Table

R variables Combination Code	R1 group choice	R2 group choice	R3 group choice	R4 group choice
R01	R1	R2	R3	R4
R02	R1	R2	R3	PG1-R4
R03	R1	R2	PG1-R3	R4
R04	R1	R2	PG1-R3	PG1-R4
R05	R1	PG1-R2	R3	R4
R06	R1	PG1-R2	R3	PG1-R4
R07	R1	PG1-R2	PG1-R3	R4
R08	R1	PG1-R2	PG1-R3	PG1-R4
R09	PG1-R1	R2	R3	R4
R10	PG1-01	R2	R3	PG1-R4
R11	PG1-R1	R2	PG1-R3	R4
R12	PG1-R1	R2	PG1-R3	PG1-R4
R13	PG1-R1	PG1-R2	R3	R4
R14	PG1-R1	PG1-R2	R3	PG1-R4
R15	PG1-R1	PG1-R2	PG1-R3	R4
R16	PG1-R1	PG1-R2	PG1-R3	PG1-R4

Thus, for example, the substituent combination, "R14" describes a substituent combinatorial choice for Formula (I) wherein R1 is selected from the preferred set of variables, "PG1-R1", that is, methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, and 2-propenyl; the R2 substituent is selected from the preferred set of

variables, "PG1-R2", that is, hydrogen or methyl, ethyl, methoxy, ethoxy, halo, or $-CF_3$; the variable R3 has the scope defined in the generic formula (I), and the substituents suitable for R4 are selected from the preferred group, "PG1-R4" having the preferred set of variables, ethyl, propyl, and isopropyl.

The following Y-Table is used to select broad and preferred groupings of the variables Y1, Y2, and Y3 for substitution in formula (I), as follows:

Y-Table

Y variables combination code	Y1 group choice	Y2 group choice	Y3 group choice
Y01	Y1	Y2	Y3
Y02	Y1	Y2	PG1-Y3
Y03	Y1	Y2	PG2-Y3
Y04	Y1	PG1-Y2	Y3
Y05	Y1	PG2-Y2	Y3
Y06	Y1	PG1-Y2	PG1-Y3
Y07	Y1	PG1-Y2	PG2-Y3
Y08	Y1	PG2-Y2	PG1-Y3
Y09	Y1	PG2-Y2	PG2-Y3
Y10	PG1-Y1	Y2	Y3
Y11	PG1-Y1	Y2	PG1-Y3
Y12	PG1-Y1	Y2	PG2-Y3
Y13	PG1-Y1	PG1-Y2	Y3
Y14	PG1-Y1	PG1-Y2	PG1-Y3
Y15	PG1-Y1	PG1-Y2	PG2-Y3
Y16	PG1-Y1	PG2-Y2	Y3
Y17	PG1-Y1	PG2-Y2	PG1-Y3
Y18	PG1-Y1	PG2-Y2	PG2-Y3
Y19	PG2-Y1	Y2	Y3
Y20	PG2-Y1	Y2	PG1-Y3
Y21	PG2-Y1	Y2	PG2-Y3
Y22	PG2-Y1	PG1-Y2	Y3
Y23	PG2-Y1	PG1-Y2	PG1-Y3
Y24	PG2-Y1	PG1-Y2	PG2-Y3
Y25	PG2-Y1	PG2-Y2	Y3
Y26	PG2-Y1	PG2-Y2	PG1-Y3
Y27	PG2-Y1	PG2-Y2	PG2-Y3

The following XZn-Table is used to select broad and preferred groupings of the variables X, Z, and n for substitution in formula (I), as follows:

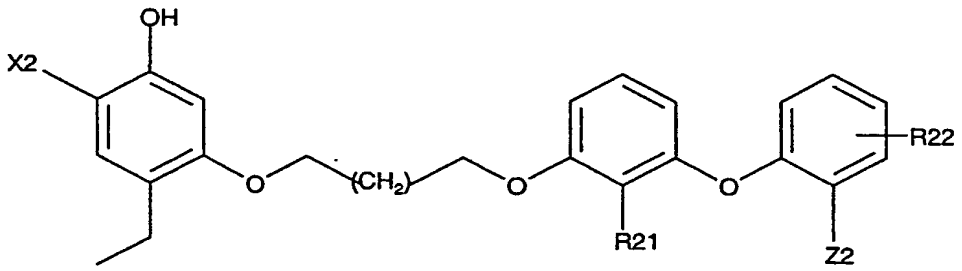
XZn-Table

XZn variables combination code	X group choice	Z Group Choice	n integer group choice
XZn01	X	Z	n
XZn02	X	Z	PG1-n
XZn03	X	Z	PG2-n
XZn04	X	PG1-Z	n
XZn05	X	PG2-Z	n
XZn06	X	PG3-Z	n
XZn07	X	PG1-Z	PG1-n
XZn08	X	PG2-Z	PG1-n
XZn09	X	PG3-Z	PG1-n
XZn10	X	PG1-Z	PG2-n
XZn11	X	PG2-Z	PG2-n
XZn12	X	PG3-Z	PG2-n
XZn13	PG1-X	Z	n
XZn14	PG1-X	Z	PG1-n
XZn15	PG1-X	Z	PG2-n
XZn16	PG1-X	PG1-Z	n
XZn17	PG1-X	PG2-Z	n
XZn18	PG1-X	PG3-Z	n
XZn19	PG2-X	PG1-Z	PG1-n
XZn20	PG2-X	PG2-Z	PG1-n
XZn21	PG2-X	PG3-Z	PG1-n
XZn22	PG2-X	PG1-Z	PG2-n
XZn23	PG2-X	PG2-Z	PG2-n
XZn24	PG2-X	PG3-Z	PG2-n

How to Use the Tables:

Any of the individual 16 combinations of the R substituents depicted in the R-Table may be used in combination with any of the 27 individual combinations of Y substituents depicted in the Y-Table, which may be used with any of the 24 combinations of XZn substituents depicted in the XZn-Table. For example, the substituent combination choice "R07, Y21, XZn03" defines substituent set selections for a subset of formula (I) useful in the practice of the composition and method of invention.

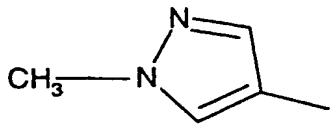
III Q. Additional preferred LTB_4 antagonists are described by formula (II):



(II)

wherein;

X2 is a heterocyclic radical selected from,



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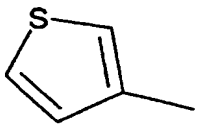

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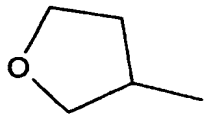
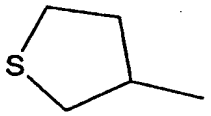


, or



;

R21 is ethyl, 2-propen-1-yl, 3-propen-1-yl, n-propyl, iso-propyl, n-butyl, sec-butyl, or tert-butyl; and

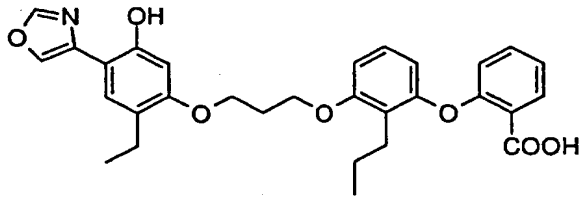
R22 is hydrogen, n-butyl, sec-butyl, flouro, chloro, $-CF_3$, or tert-butyl.

Z2 is carboxyl, tetrazolyl, N-sulfonamidyl.

Preferred Compounds of the Invention:

III R. Specific compounds preferred as LTB_4 antagonist component of the composition and method of the invention are represented by the following structural formulae:

(C1):



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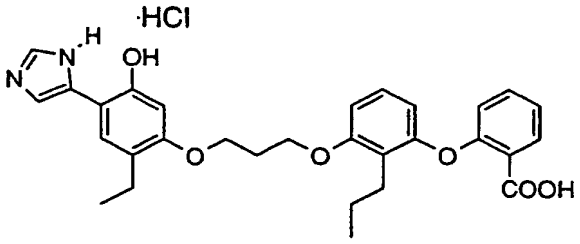

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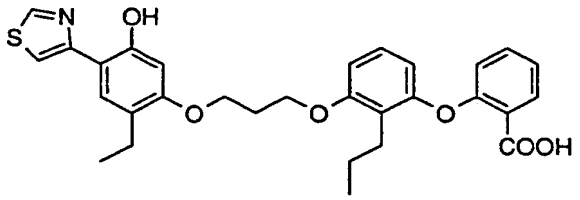

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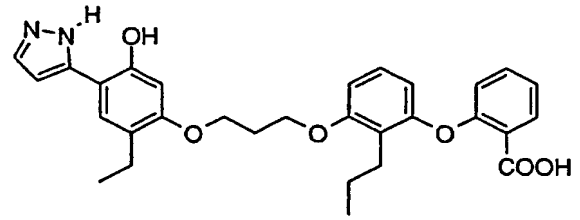

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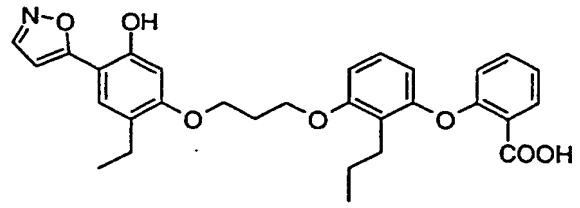

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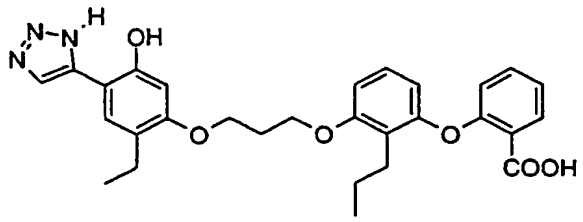

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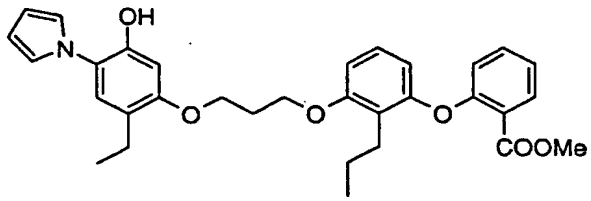

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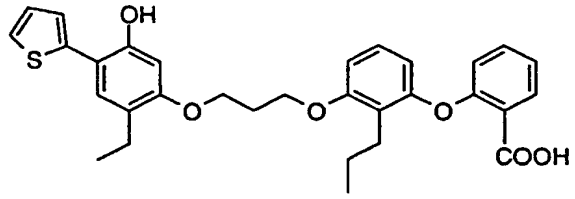

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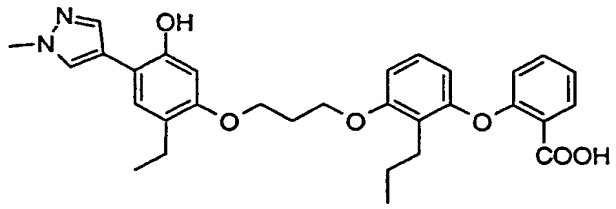

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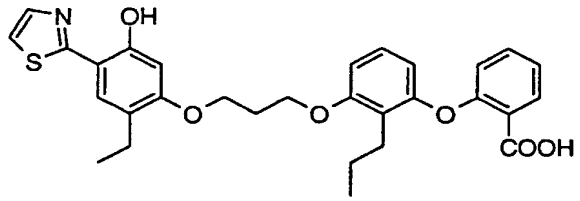

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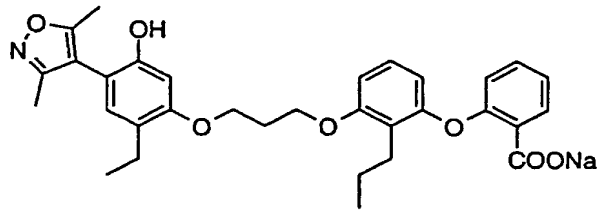

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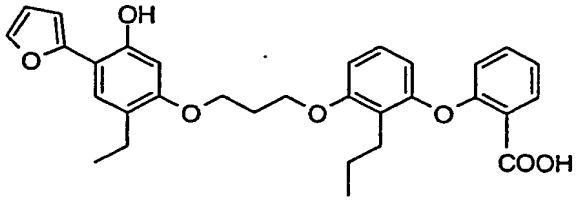

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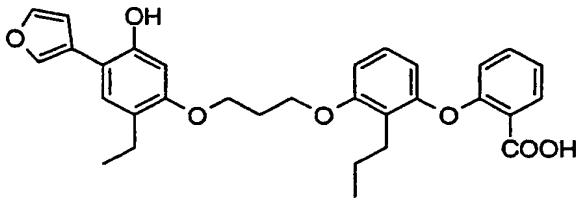

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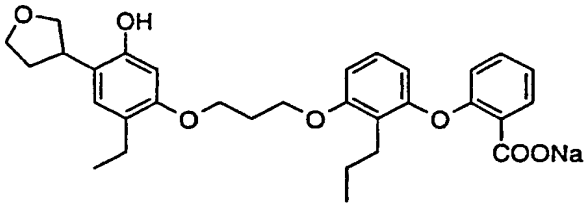

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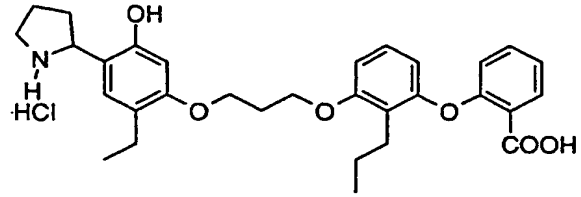

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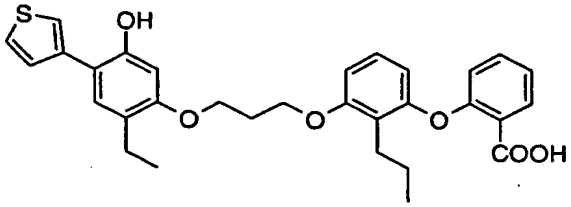

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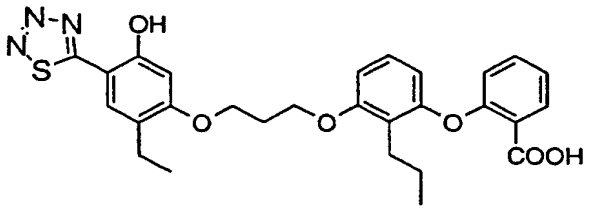

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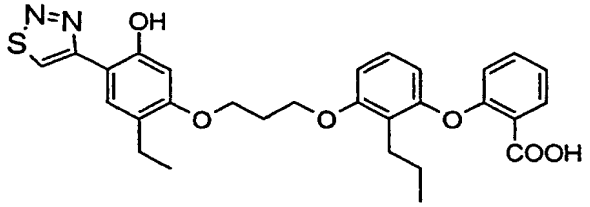

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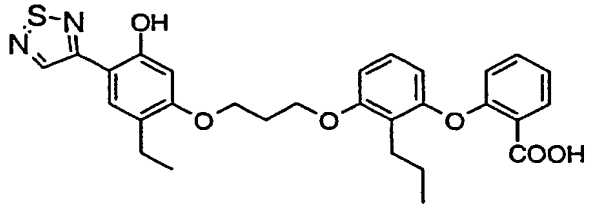

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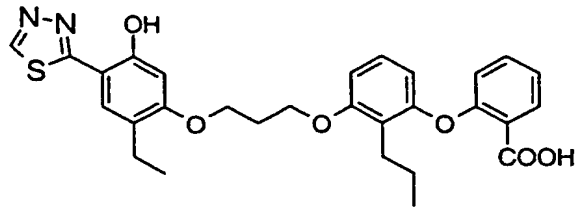

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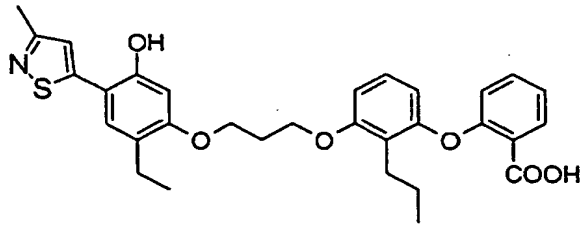

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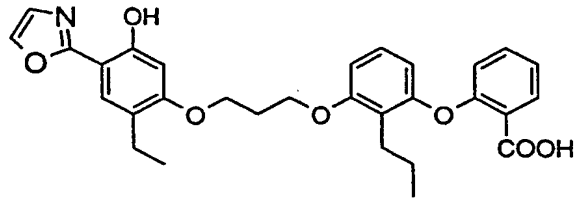
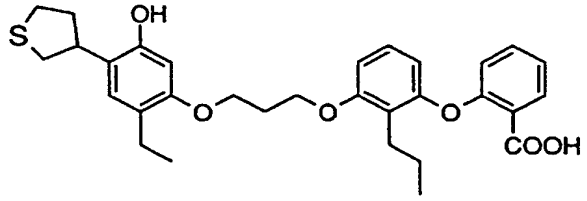
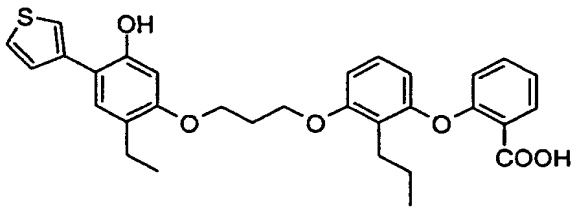


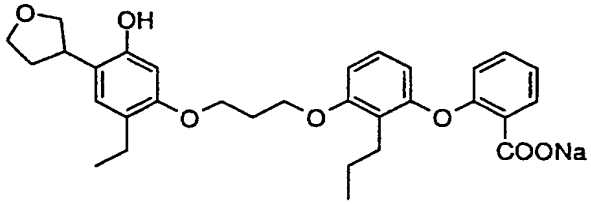
(C23):



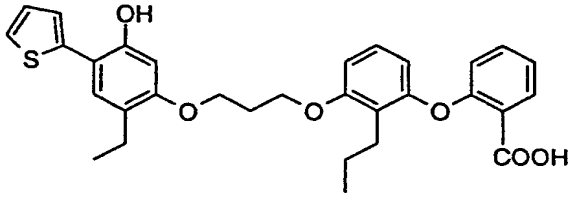
and all acid, salt, solvate and prodrug derivatives thereof.

III S. Highly Preferred LTB_4 Antagonists are as follows:

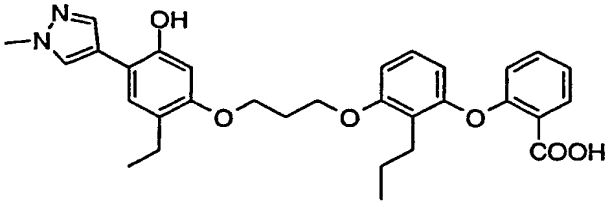


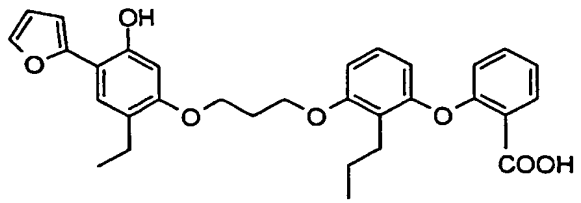


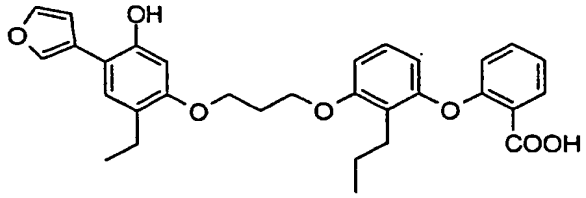
5



10







and all acid, salt, solvate and prodrug derivatives thereof.

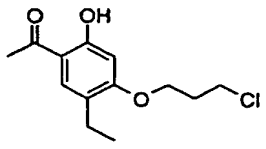
IV. Method of Making the LTB_4 Antagonist Compounds of the Composition and Method of the Invention

General reaction schemes (not represented to be specific Examples) applicable for synthesis of the LTB_4 antagonist compounds represented by formula (I) are set out below. Numerous literature references and Chemical Abstract registry numbers (e.g., RN 152609-60-4) are supplied as additional aids for preparing reagents used in practicing the synthesis schemes of the invention.

REACTION SCHEMES FOR MAKING LTB_4 ANTAGONIST COMPOUNDS USED IN THE COMPOSITIONS AND METHOD OF THE INVENTION

The following scheme illustrates a process for making Example (1), a 4-substituted oxazole LTB_4 receptor antagonist:

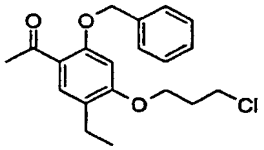
Scheme 1



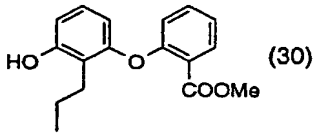
(26)

benzyl bromide, Cs_2CO_3, DMF

known compound: RN# 156005-61-7
R. W. Harper et al., J. Med. Chem. 1994, *37(15)*, 2411



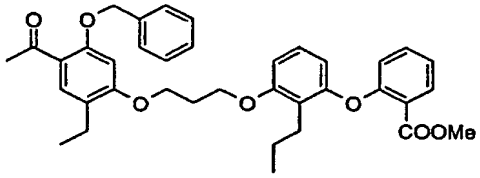
(28)



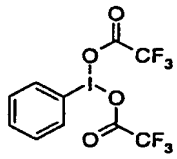
(30)

known compound: RN 152609-76-2
J. S. Sawyer et al., J. Med. Chem. 1995, *38*, 4411

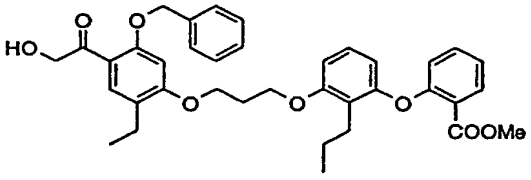
K_2CO_3, NaI, 2-butanone



(32)



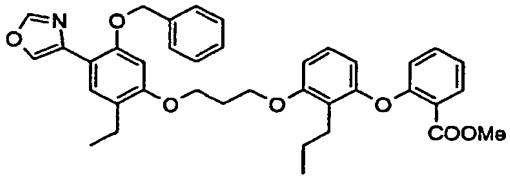
TFA, H_2O, CH_3CN



(34)

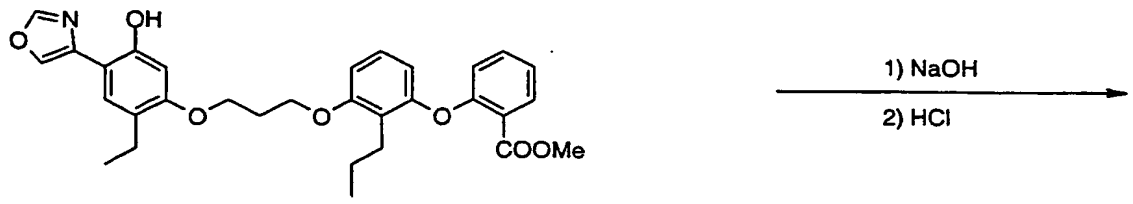
1) Tf_2O, 2,6-lutidine

2) formamide

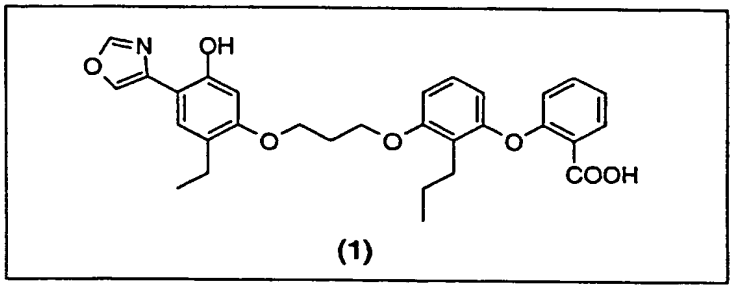


(36)

$BF_3{\cdot}Et_2O$, EtSH



(38)



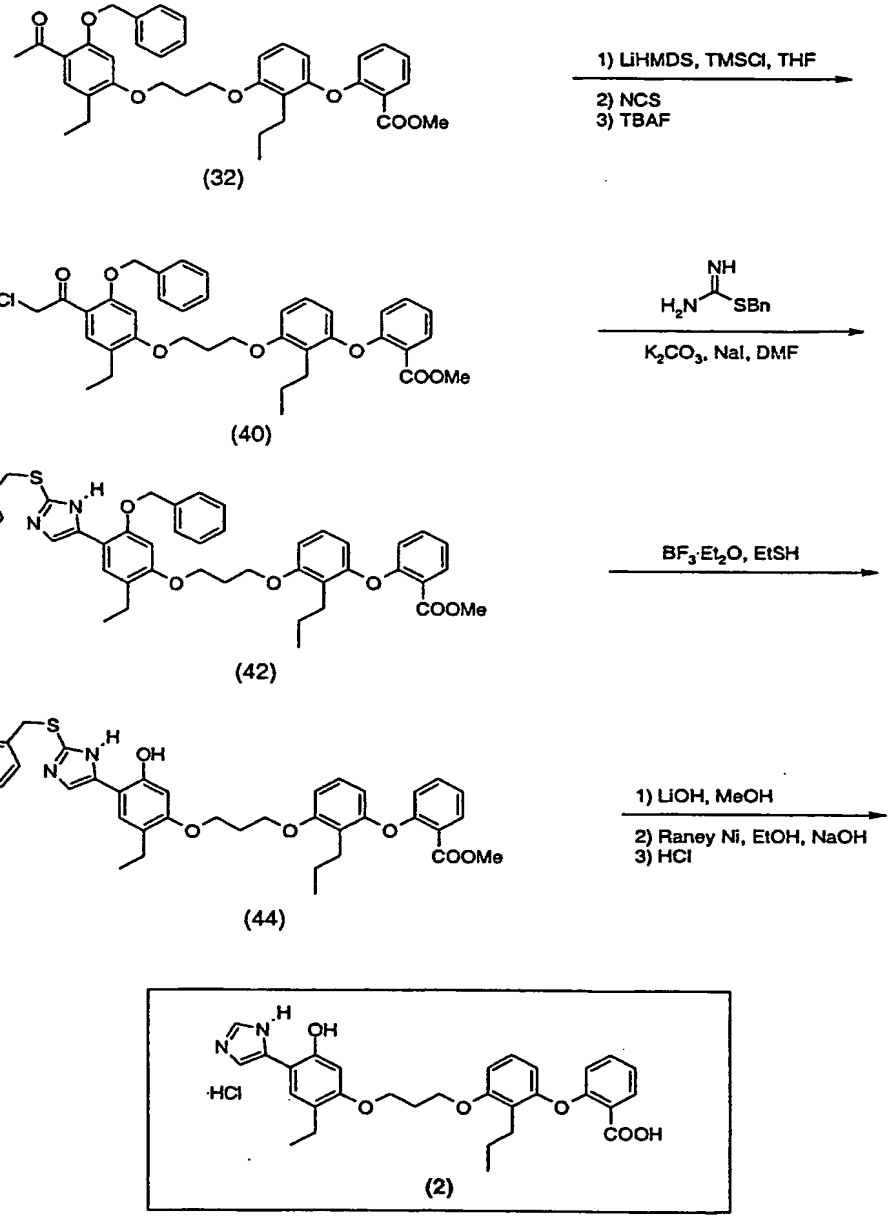
(1)

Known chloride (26) may be alkylated with benzyl bromide to provide chloride (28). Reaction with known ester (30), catalyzed by a suitable base, provides acetophenone (32). Oxidation with bis(trifluoroacetoxy)iodobenzene gives alpha-hydroxy ketone (34), that may be cyclized with triflic anhydride and formamide to give the 4-substituted oxazole (36). Debenzylation with boron trifluoride etherate and ethanethiol gives oxazole (38), that is hydrolyzed and protonated to provide Example (1).

Scheme 2

The following scheme illustrates a process for making Example (2), a 5(4)-substituted imidazole LTB_4 receptor antagonist:

Scheme 2

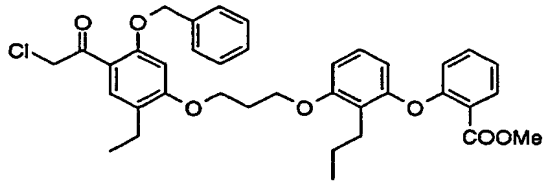

1) LiHMDS, TMSCl, THF
2) NCS
3) TBAF
NH
H2N
SBn
K2CO3, NaI, DMF
BF3·Et2O, EtSH
1) LiOH, MeOH
2) Raney Ni, EtOH, NaOH
3) HCl
COOMe
COOH
OH
HCl
Cl
(32)
(40)
(42)
(44)
(2)

The trimethylsilyl enol ether of acetophenone (32) is formed and treated with N-chlorosuccinimide followed by tetra-*n*-butylammonium fluoride to provide the chloroketone (40). Treatment of (40) with 2-benzyl-2-thiopseudourea and base provides imidazole (42), that is treated with boron trifluoride etherate and ethanethiol to give imidazole (44). Hydrolysis and protonation provide Example (2) as the hydrochloride salt.

Scheme 3

The following scheme illustrates a process for making Example (3), a 4-substituted thiazole LTB_4 receptor antagonist:

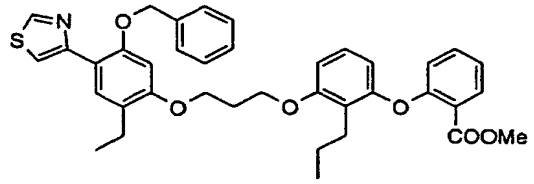
Scheme 3



(40)

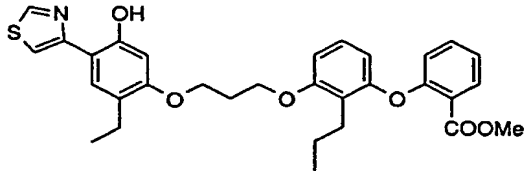
thioformamide, $MgCO_3$

dioxane



(46)

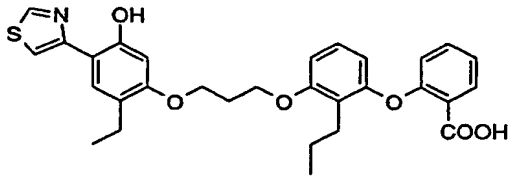
$BF_3{\cdot}Et_2O$, EtSH



(48)

1) LiOH, MeOH

2) HCl



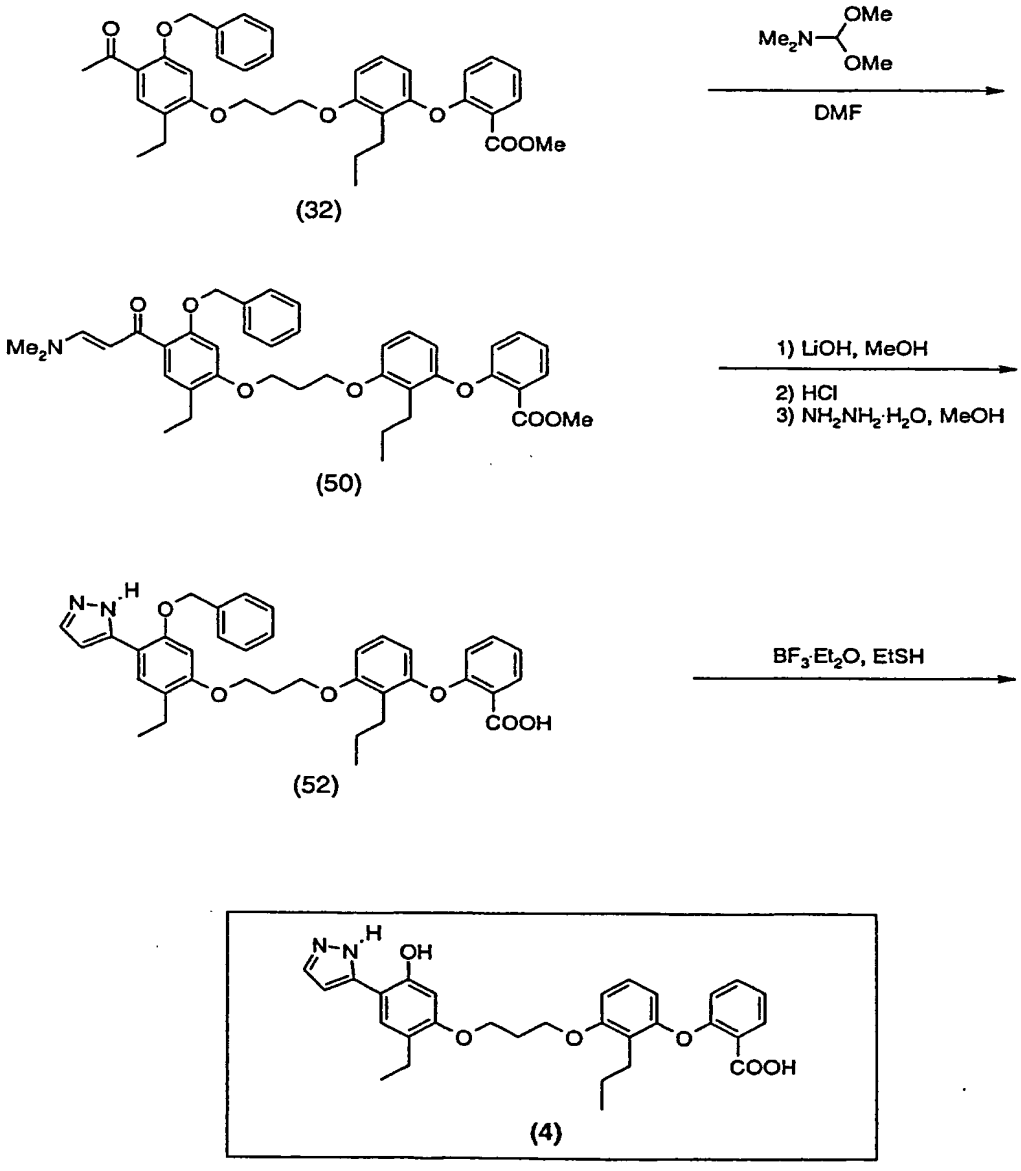
(3)

Chloroketone (40) is treated with thioformamide and magnesium carbonate to give thiazole (46), that is debenzylated with boron trifluoride etherate and ethanethiol giving thiazole (48). Hydrolysis and protonation provides Example (3).

Scheme 4

The following scheme illustrates a process for making Example (4), a 5(3)-substituted pyrazole LTB_4 receptor antagonist:

Scheme 4

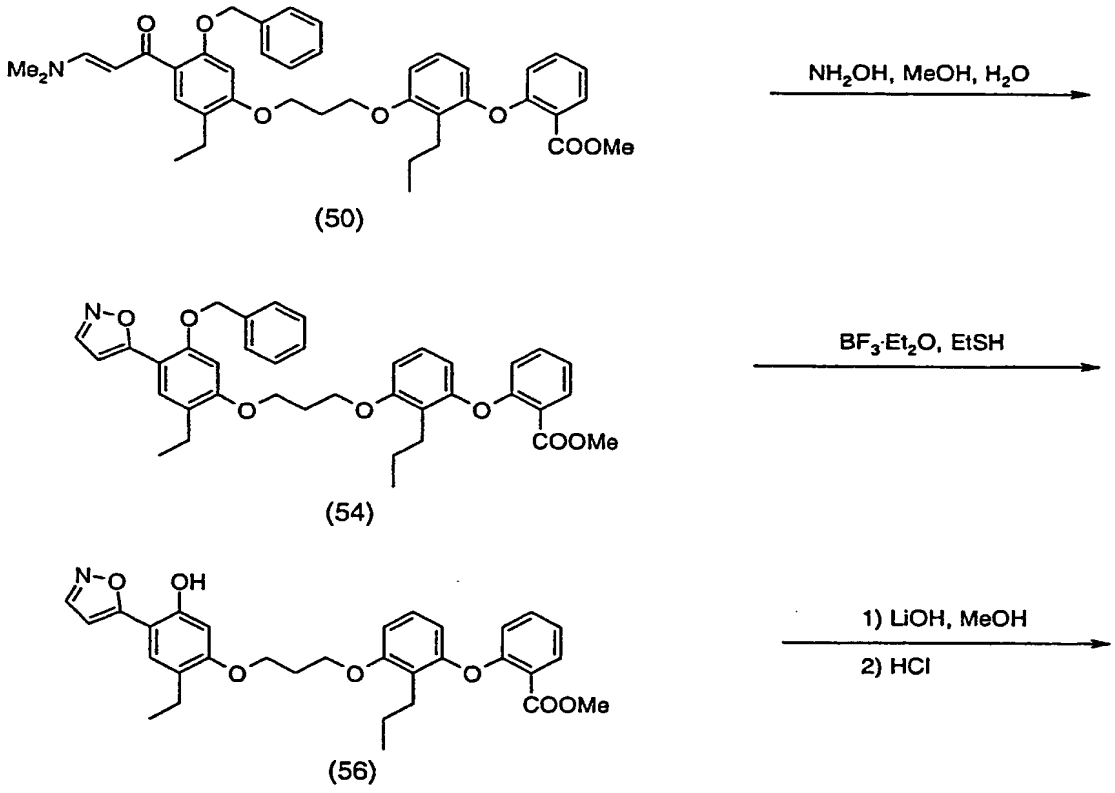

Me2N
OMe
OMe
DMF
COOMe
(32)
Me2N
COOMe
(50)
1) LiOH, MeOH
2) HCl
3) NH2NH2·H2O, MeOH
COOH
(52)
BF3·Et2O, EtSH
OH
COOH
(4)

Treatment of acetophenone (32) with N,N-dimethylformamide dimethyl acetal gives enone (50), that may be hydrolyzed, protonated, and then heated with hydrazine hydrate to provide pyrazole (52). Debenzylation of the resulting pyrazole with boron trifluoride etherate and ethanethiol gives Example (4).

Scheme 5

The following scheme illustrates a process for making Example (5), a 5-substituted isoxazole LTB_4 receptor antagonist:

Scheme 5

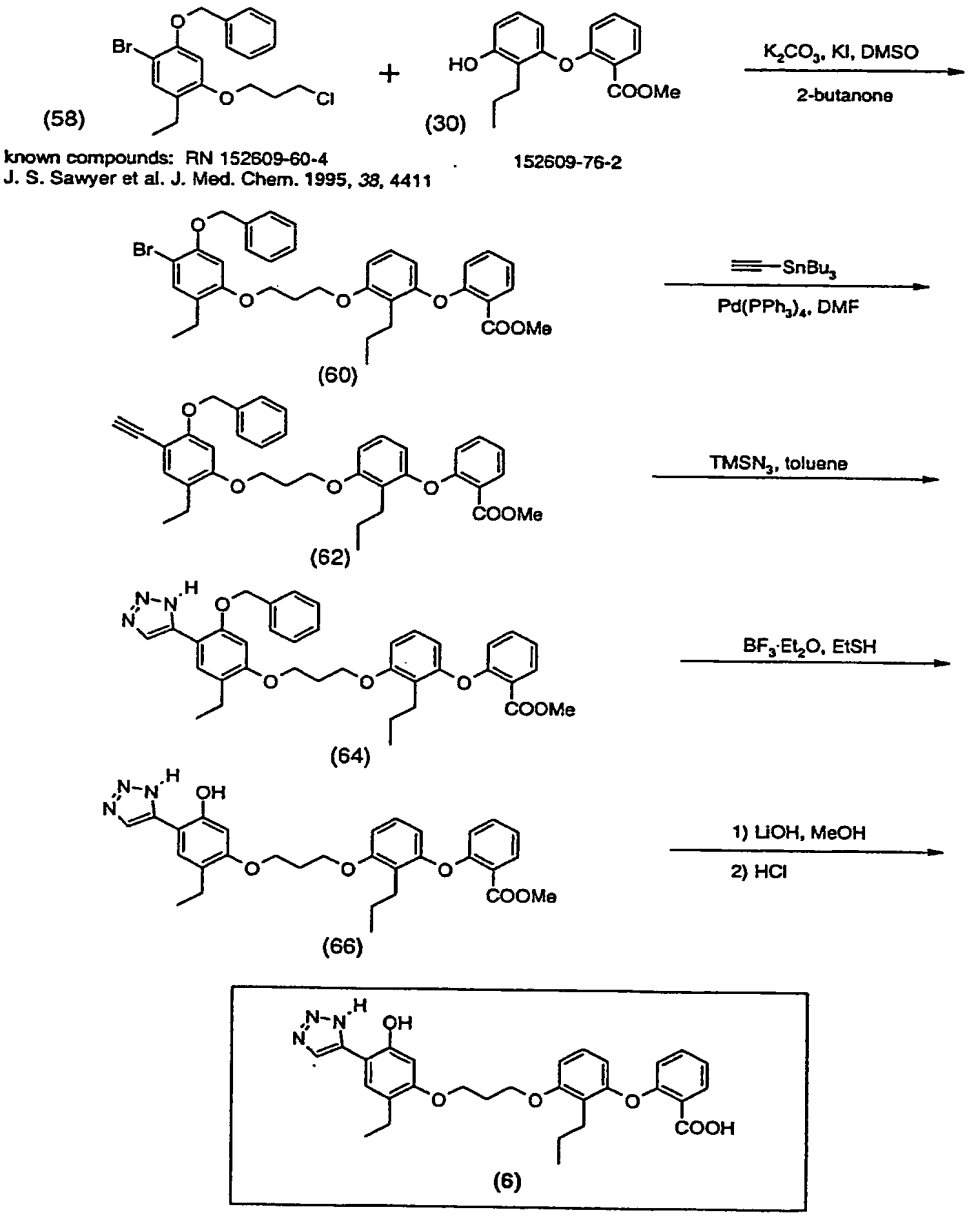

Me2N
O
O
O
O
O
COOMe
NH2OH, MeOH, H2O
(50)
N-O
O
O
O
O
COOMe
BF3·Et2O, EtSH
(54)
N-O
OH
O
O
O
COOMe
1) LiOH, MeOH
2) HCl
(56)
N-O
OH
O
O
O
COOH
(5)

Treatment of enone (50) with hydroxylamine provides isoxazole (54), that is debenzylated with boron trifluoride etherate and ethanethiol to give isoxazole (56). Hydrolysis and protonation provides Example (5).

Scheme 6

The following scheme illustrates a process for making Example (6), a 5(4)-substituted 1,2,3-triazole LTB_4 receptor antagonist:

Scheme 6

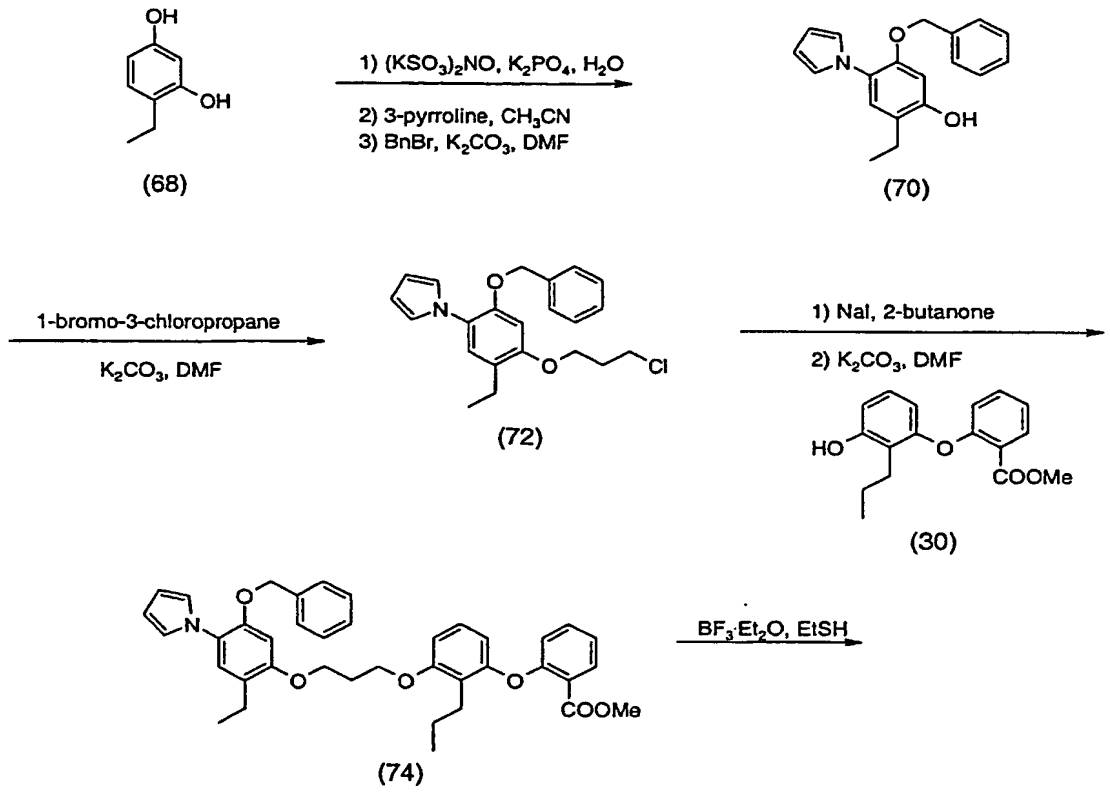

Br
O
O
Cl
(58)
+
HO
O
COOMe
(30)
K_2CO_3, KI, DMSO
2-butanone
known compounds: RN 152609-60-4
J. S. Sawyer et al. J. Med. Chem. 1995, 38, 4411
152609-76-2
Br
O
O
O
COOMe
(60)
$SnBu_3$
$Pd(PPh_3)_4$, DMF
O
O
O
COOMe
(62)
$TMSN_3$, toluene
N
N
H
O
O
O
COOMe
(64)
$BF_3{\cdot}Et_2O$, EtSH
N
N
H
OH
O
O
O
COOMe
(66)
1) LiOH, MeOH
2) HCl
N
N
H
OH
O
O
O
COOH
(6)

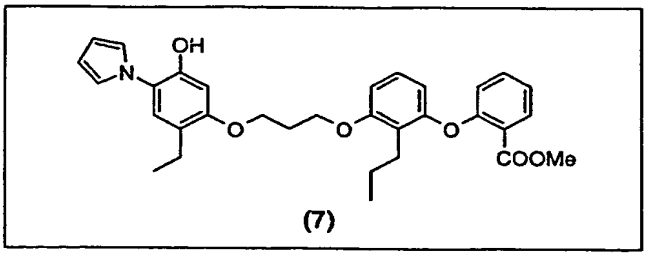
Known phenol (30) is alkylated with known chloride (58) to give aryl bromide (60). Treatment of (60) with tri-*n*-butylethynyltin and a palladium catalyst gives alkyne (62). Heating (62) with trimethylsilyl azide provides triazole (64), that is debenzylated with boron trifluoride etherate and ethanethiol to give triazole (66). Hydrolysis and protonation provides Example (6).

Scheme 7

The following scheme illustrates a process for making Example (7), a 1-substituted pyrrole LTB_4 receptor antagonist:

Scheme 7





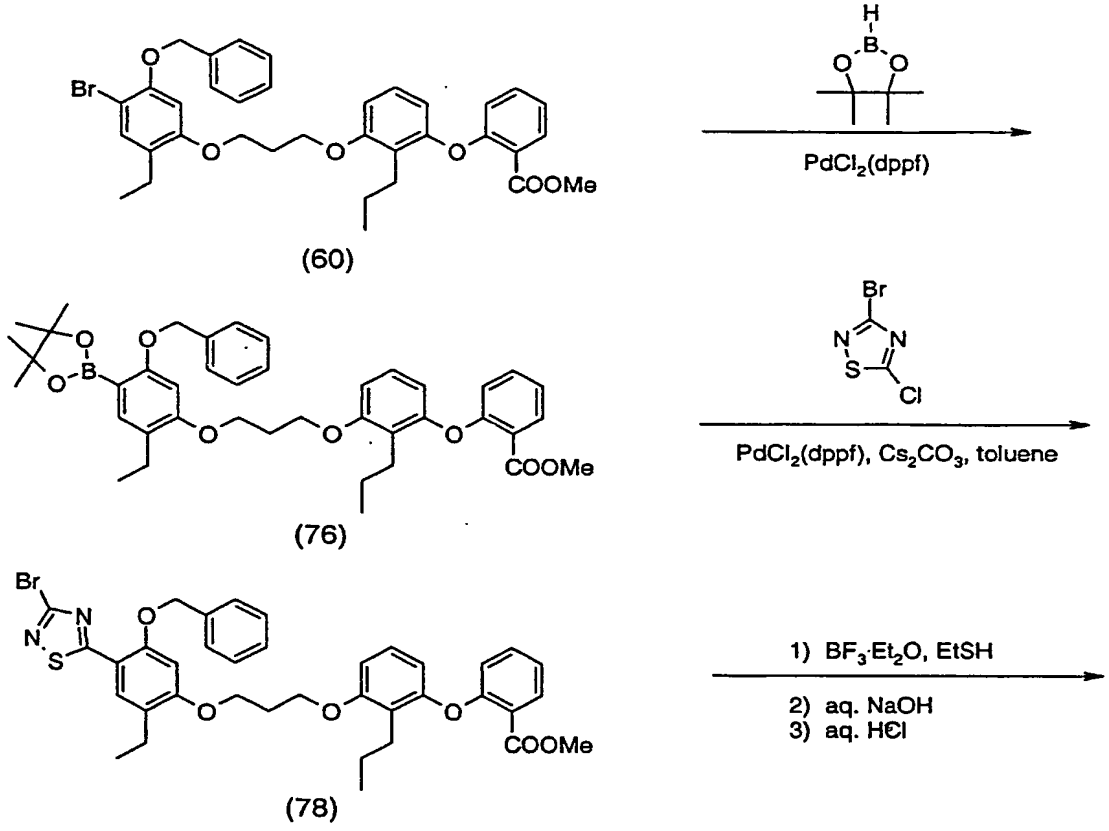
References for formation of 1-aryl substituted pyrroles: M. Mure and J. P. Klinman, J. Am. Chem. Soc. 1995, *117(34)*, 8698; Y. Lee et al. J. Am. Chem. Soc. 1996, *118(30)*, 7241

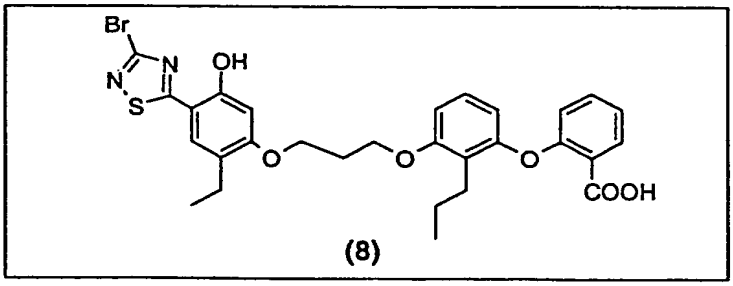
4-Ethylbenzene-1,3-diol (68) is treated with potassium nitrosodisulfonate followed by 3-pyrroline and benzylbromide and a base to provide pyrrole (70). Alkylation with 1-bromo-3-chloropropane gives chloride (72), that is used to alkylate phenol (30) to give pyrrole (74). Debenzylation with boron trifluoride etherate and ethanethiol provides Example (7).

Scheme 8

The following scheme illustrates a process for making Example (8), a 5-substituted 1,2,4-thiadiazole LTB_4 receptor antagonist:

Scheme 8


Br
O
O
O
O
COOMe
(60)
H
B
O
O
PdCl2(dppf)
Br
N
N
S
Cl
PdCl2(dppf), Cs2CO3, toluene
(76)
1) BF3·Et2O, EtSH
2) aq. NaOH
3) aq. HCl
(78)

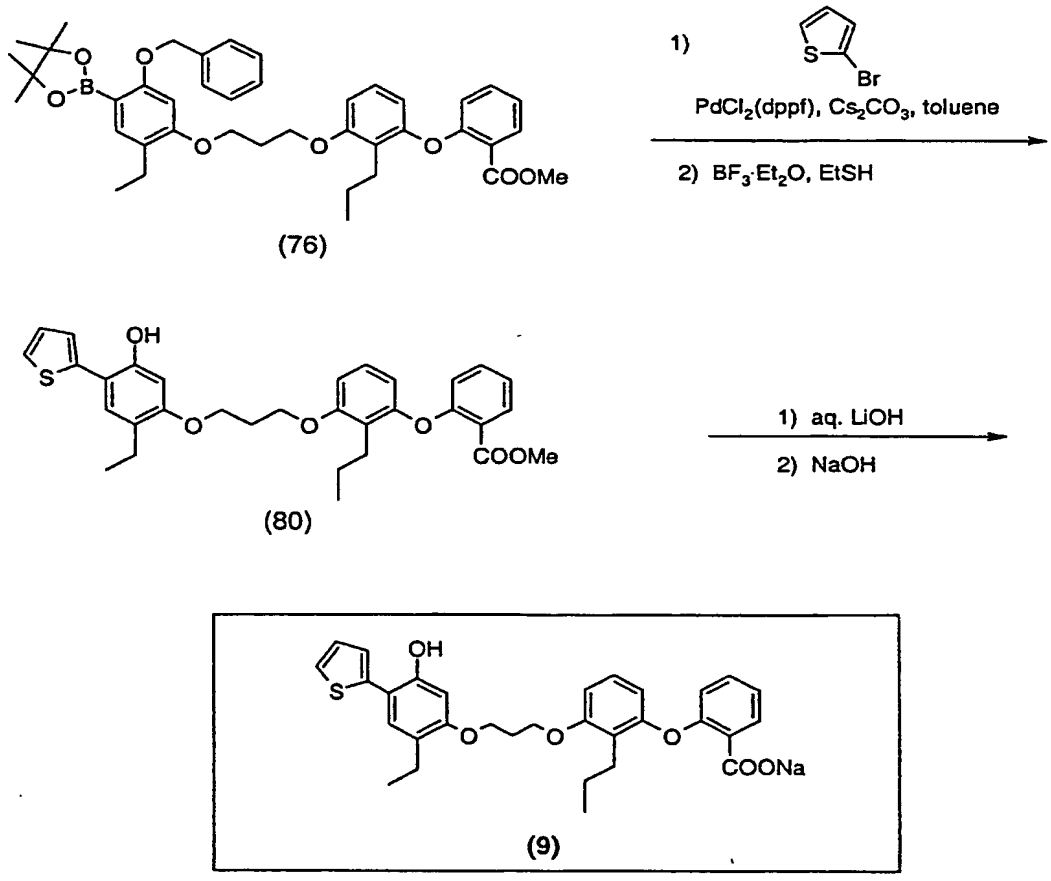

Br
N
N
S
OH
O
O
O
COOH
(8)

The palladium-catalyzed addition of 4,4,5,5-tetramethyl-[1,3,2]dioxaborolane to bromide (60) gives boronic ester (76). The palladium-catalyzed addition of 3-bromo-5-chloro-1,2,4-thiadiazole to (76) gives ester (78). Debenzylation with boron trifluoride etherate and ethanethiol, followed by hydrolysis and protonation, gives Example (8).

Scheme 9

The following scheme illustrates a process for making Example (9), a 2-substituted thiophene LTB_4 receptor antagonist:

Scheme 9



The palladium-catalyzed addition of boronic ester (76) to 2-bromothiophene, followed by debenzylation with boron trifluoride etherate and ethanethiol, provides thiophene (80). Hydrolysis and salt formation provides Example (9).

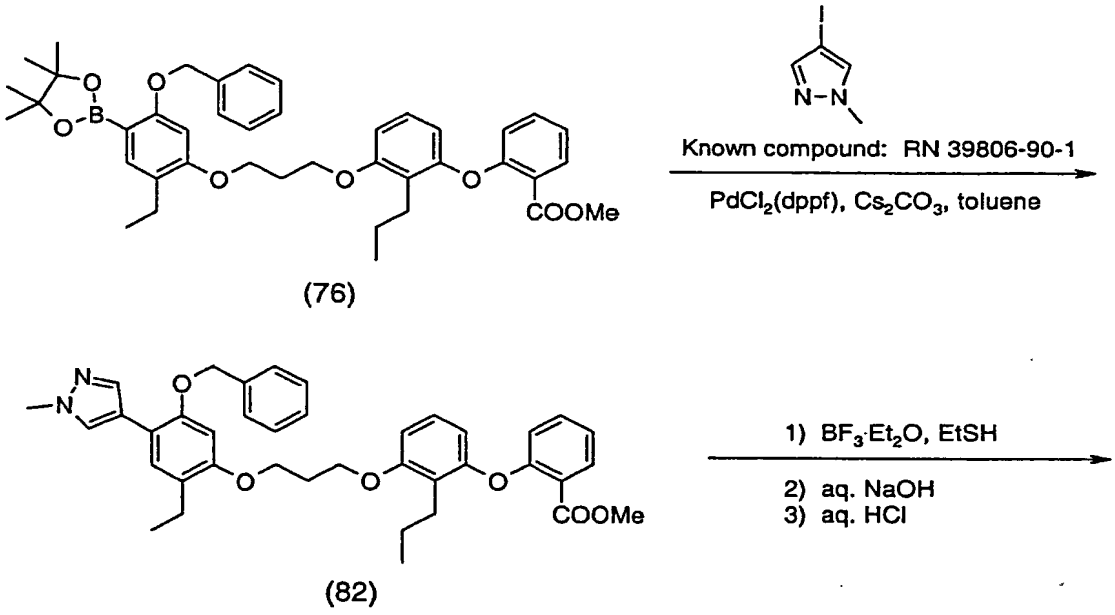
Scheme 10

The following scheme illustrates a process for making Example (10), a 4-substituted pyrazole LTB_4 receptor antagonist:

5

10

Scheme 10



(76)

(82)

(10)

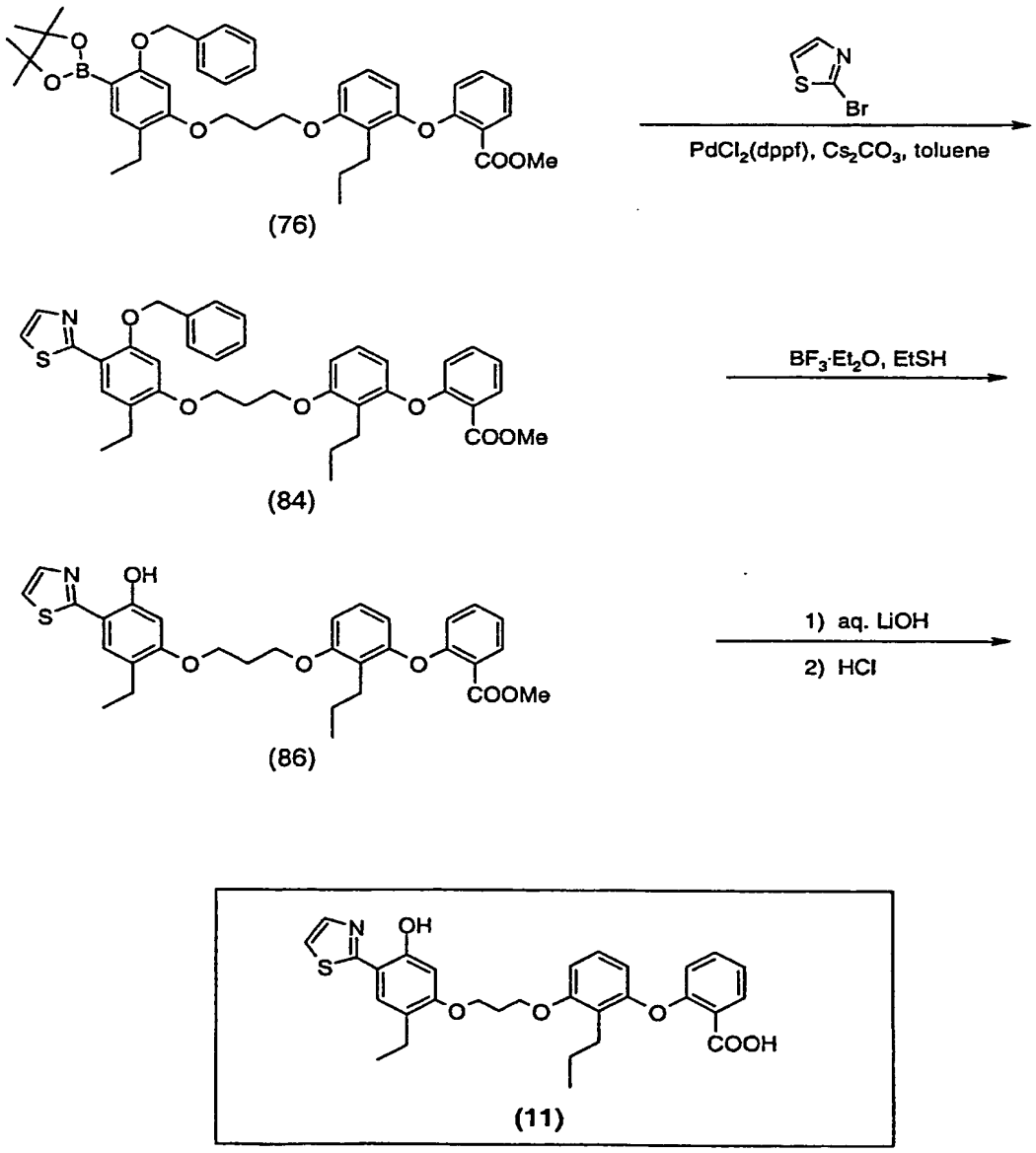
5

The palladium-catalyzed addition of boronic ester (76) to 1-methyl-4-iodopyrazole provides pyrazole (82). Debenzylation with boron trifluoride etherate and ethanethiol, followed by hydrolysis and protonation, provides Example (10).

Scheme 11

The following scheme illustrates a process for making Example (11), a 2-substituted thiazole LTB_4 receptor antagonist:

Scheme 11

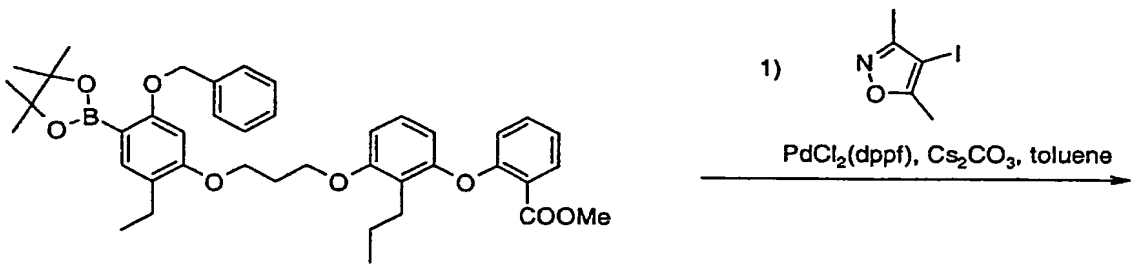

COOMe
(76)
Br
PdCl2(dppf), Cs2CO3, toluene
BF3·Et2O, EtSH
COOMe
(84)
1) aq. LiOH
2) HCl
OH
COOMe
(86)
OH
COOH
(11)

The palladium-catalyzed addition of boronic ester (76) to 2-bromothizaole provides thiazole (84). Debenzylation with boron trifluoride etherate and ethanethiol gives thiazole (86). Hydrolysis and protonation provides Example (11).

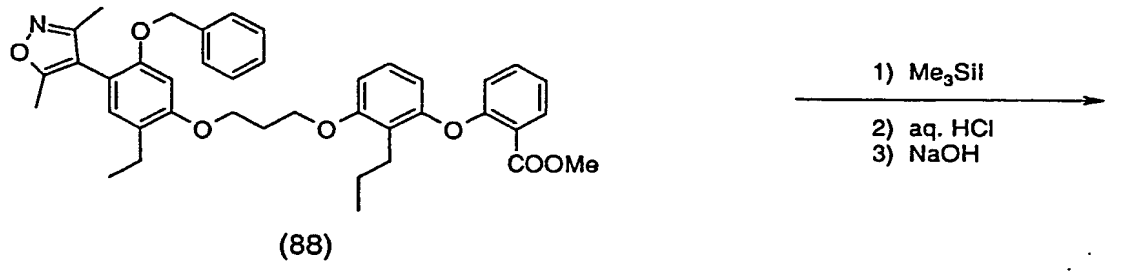
Scheme 12

The following scheme illustrates a process for making Example (12), a 4-substituted isoxazole LTB_4 receptor antagonist:

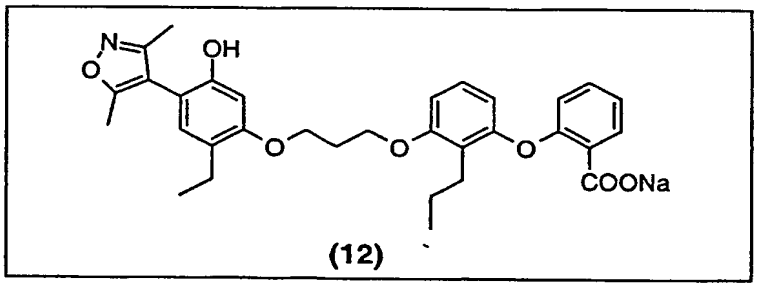
Scheme 12



(76)



(88)



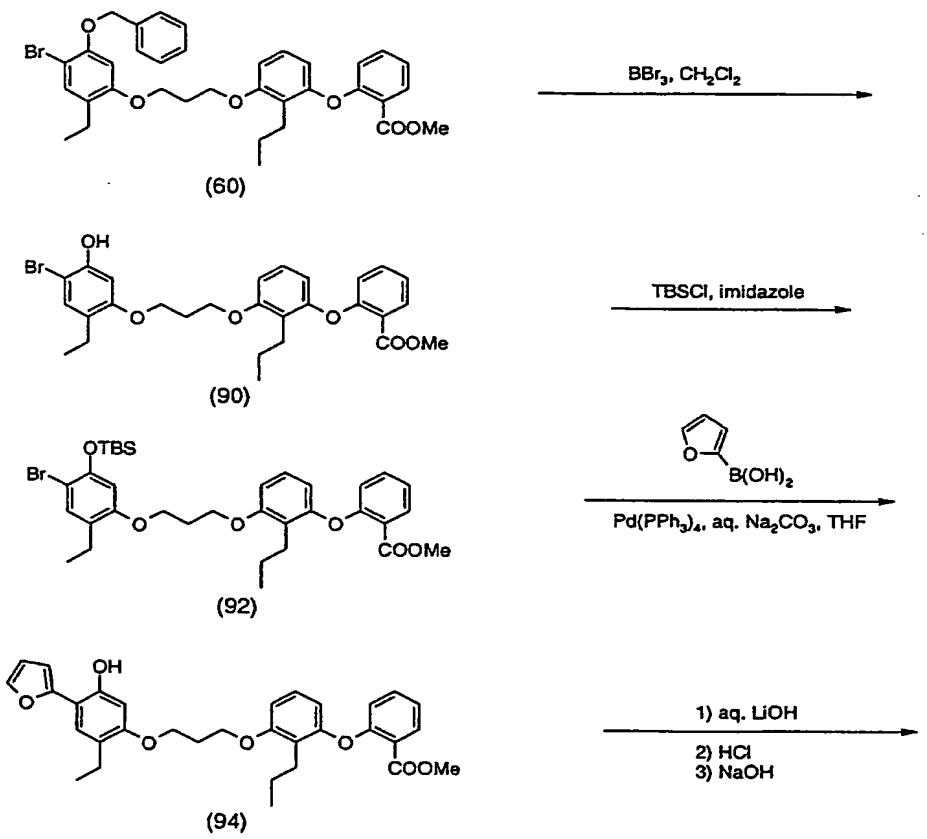
(12)

The palladium-catalyzed addition of boronic ester (76) to 3,5-dimethyl-4-iodoisoxazole provides oxazole (88). Debenzylation with trimethylsilyl iodide, followed by hydrolysis and salt formation, provides Example (12).

Scheme 13

The following scheme illustrates a process for making Example (13), a 2-substituted furan LTB_4 receptor antagonist:

Scheme 13

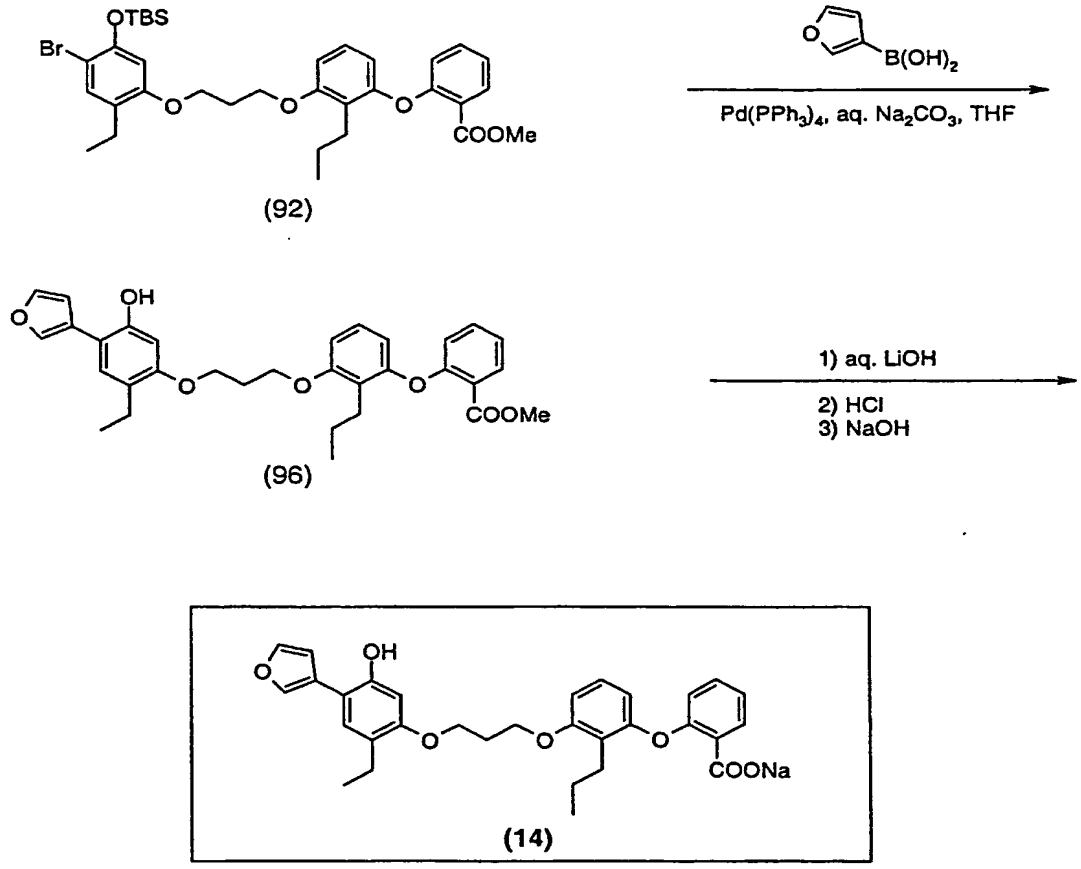

Br
O
O
O
O
COOMe
(60)
BBr3, CH2Cl2
OH
(90)
TBSCl, imidazole
OTBS
(92)
B(OH)2
Pd(PPh3)4, aq. Na2CO3, THF
(94)
1) aq. LiOH
2) HCl
3) NaOH
COONa
(13)

Debenzylation of bromide (60) with boron tribromide provides phenol (90), that is treated with *tert*-butyldimethylsilyl chloride and imidazole to give silyl ether (92). The palladium-catalyzed addition of (92) to furan-2-boronic acid provides furan (94). Hydrolysis and salt formation gives Example (13).

Scheme 14

The following scheme illustrates a process for making Example (14), a 3-substituted furan LTB_4 receptor antagonist:

Scheme 14

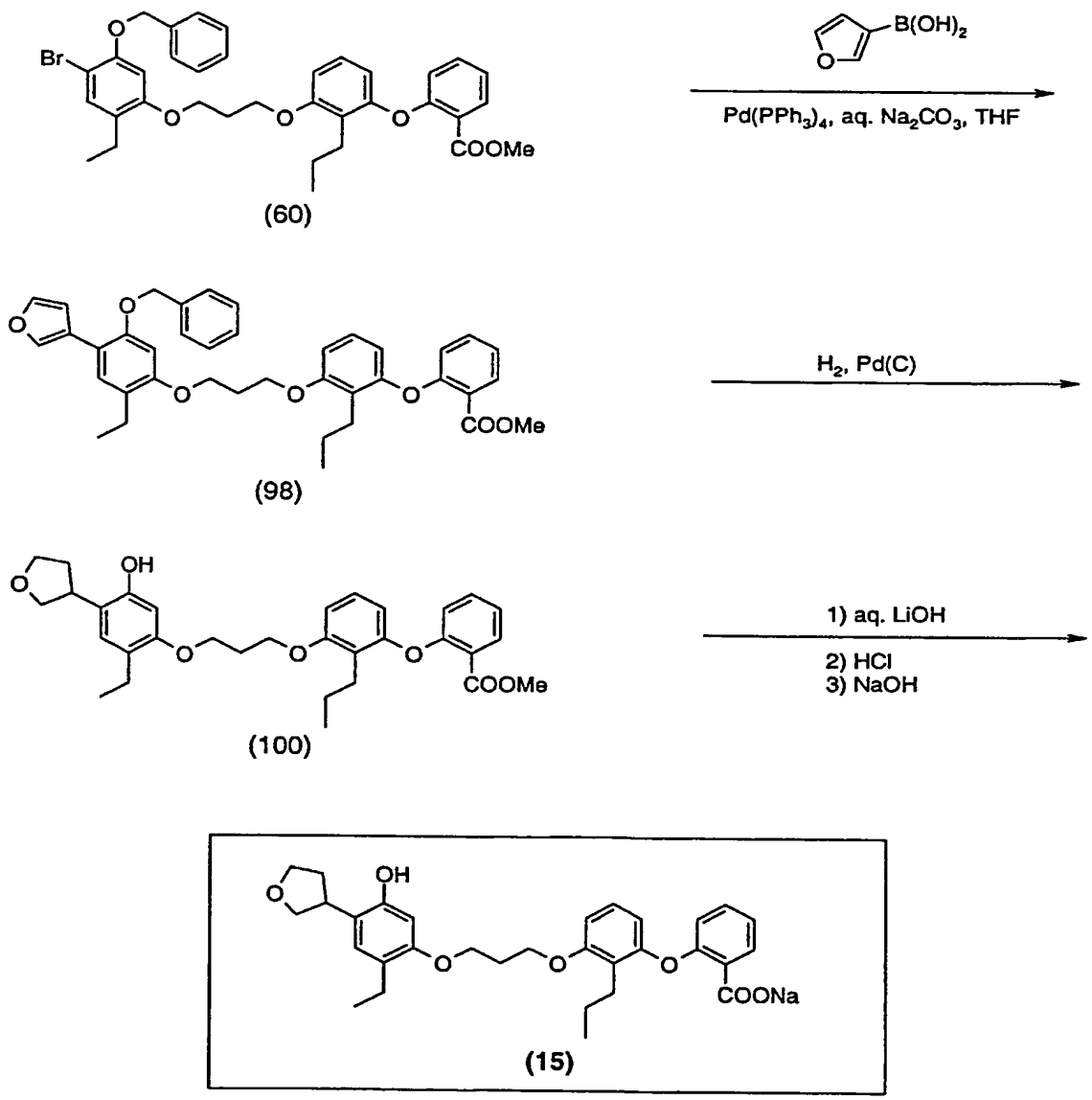


The palladium-catalyzed addition of (92) to furan-3-boronic acid provides furan (96). Hydrolysis and salt formation gives Example (14).

Scheme 15

The following scheme illustrates a process for making Example (15), a 3-substituted tetrahydrofuran LTB_4 receptor antagonist:

Scheme 15

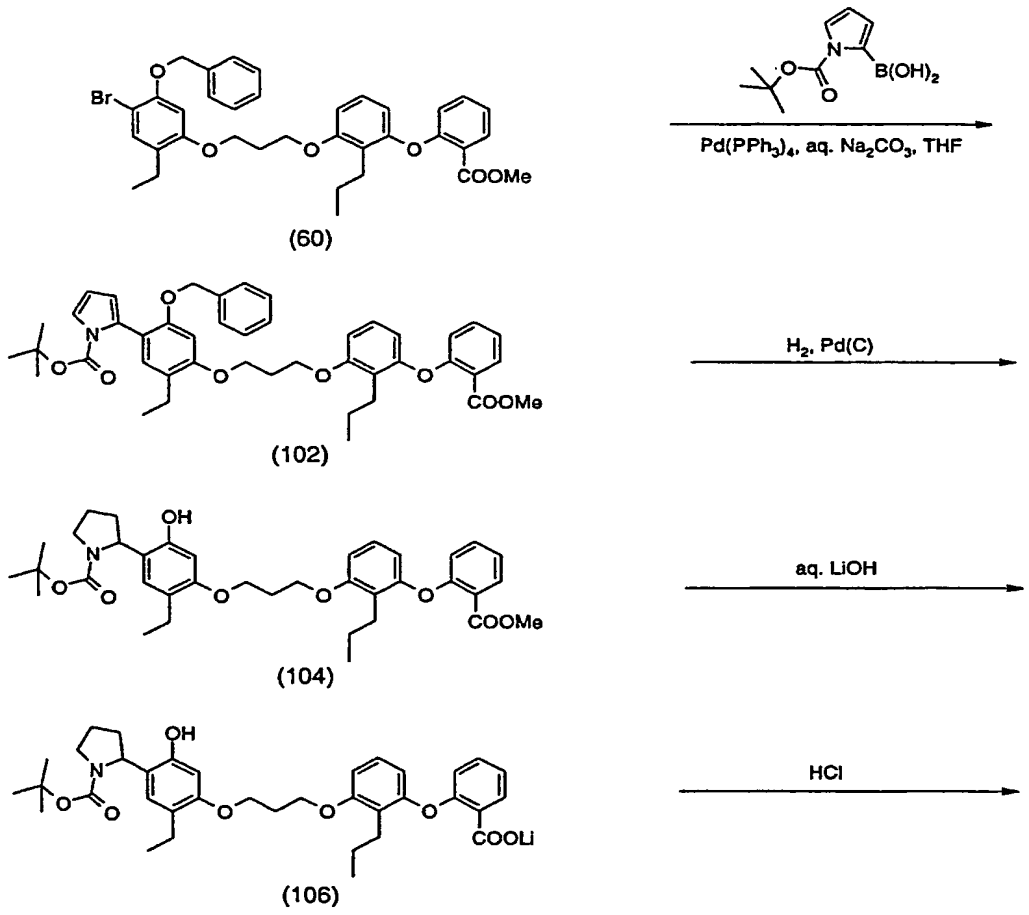

Br
COOMe
(60)
B(OH)2
Pd(PPh3)4, aq. Na2CO3, THF
COOMe
(98)
H2, Pd(C)
OH
COOMe
(100)
1) aq. LiOH
2) HCl
3) NaOH
OH
COONa
(15)

The palladium-catalyzed addition of bromide (60) to furan-3-boronic acid provides furan (98). Hydrogenation over a palladium catalyst gives tetrahydrofuran (100). Hydrolysis and salt formation gives Example (15).

Scheme 16

The following scheme illustrates a process for making Example (16), a 2-substituted pyrrolidine LTB_4 receptor antagonist:

Scheme 16

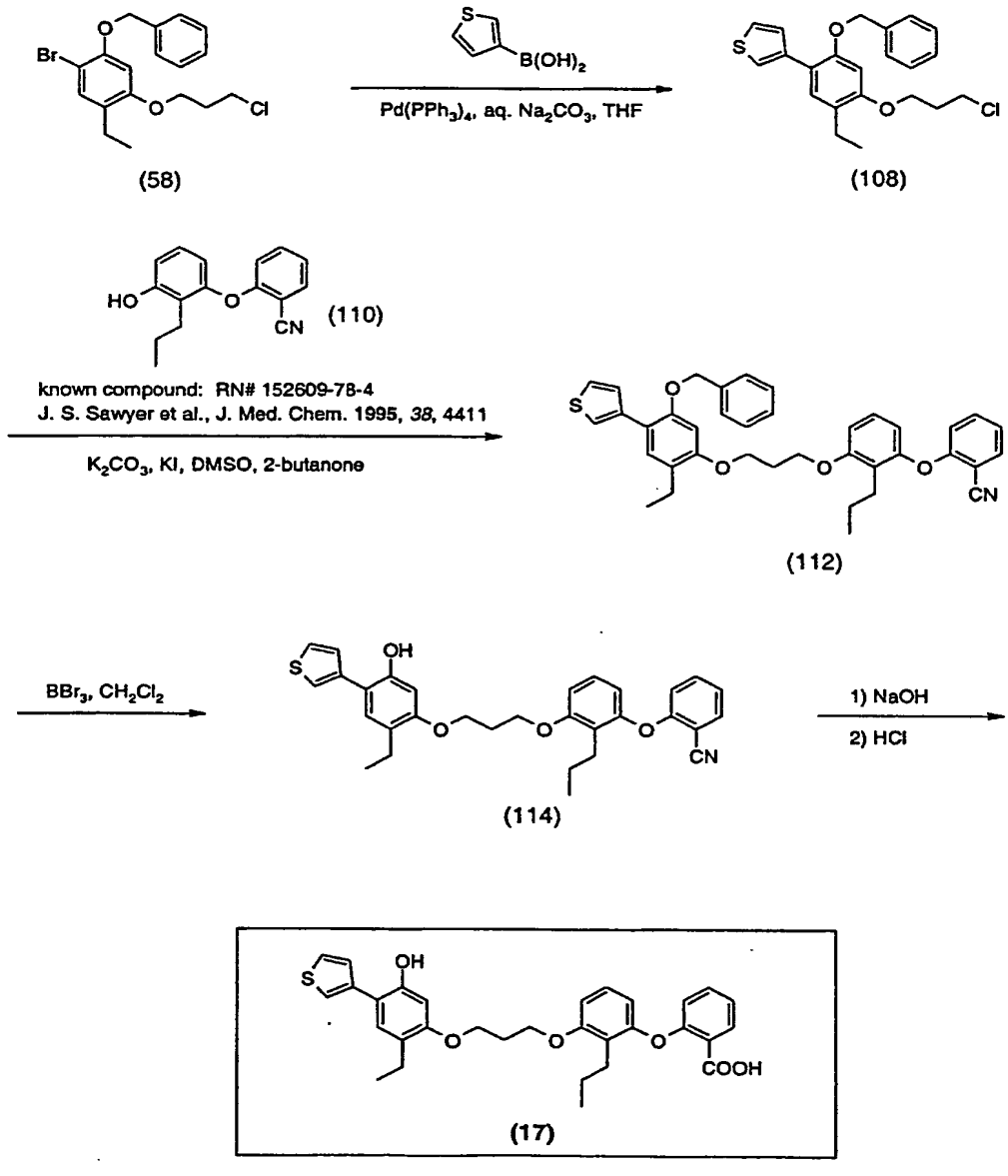

Br
COOMe
(60)
B(OH)2
Pd(PPh3)4, aq. Na2CO3, THF
H2, Pd(C)
(102)
OH
aq. LiOH
(104)
HCl
COOLi
(106)
HCl
COOH
(16)

The palladium-catalyzed addition of bromide (60) to N-boc pyrrole-2-boronic acid provides pyrrole (102). Hydrogenation over a palladium catalyst gives pyrrolidine (104). Hydrolysis and salt formation gives pyrrolidine (106). Treatment with hydrochloric acid provides Example (16) as the hydrochloride salt.

Scheme 17

The following scheme illustrates a process for making Example (17), a 3-substituted thiophene LTB_4 receptor antagonist:

Scheme 17

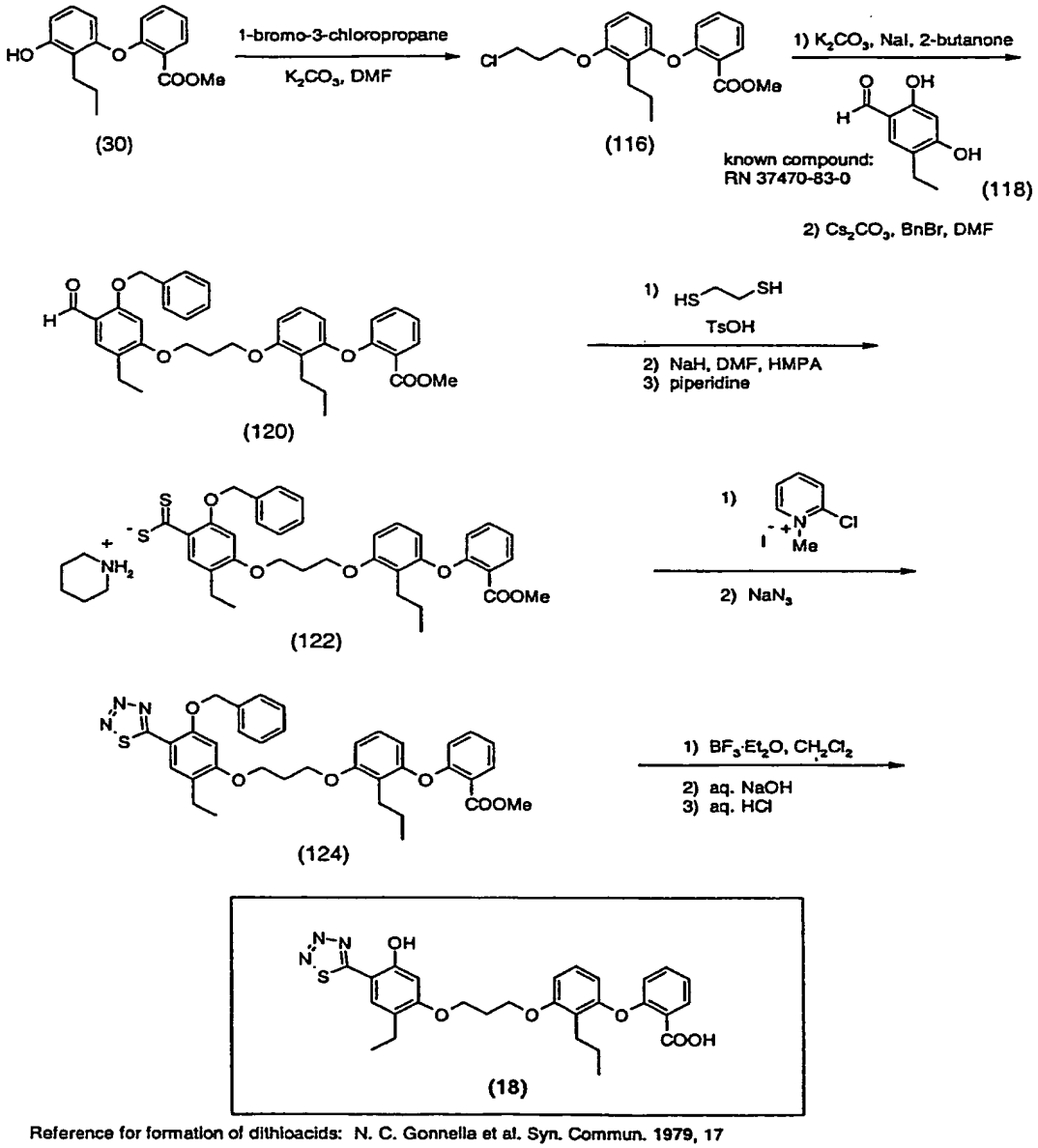

Br
O
O
Cl
S
B(OH)2
Pd(PPh3)4, aq. Na2CO3, THF
(58)
(108)
HO
O
CN
(110)
known compound: RN# 152609-78-4
J. S. Sawyer et al., J. Med. Chem. 1995, 38, 4411
K2CO3, KI, DMSO, 2-butanone
(112)
BBr3, CH2Cl2
OH
1) NaOH
2) HCl
(114)
COOH
(17)

The palladium-catalyzed addition of bromide (58) to thiophene-3-boronic acid provides thiophene (108). Alkylation of known phenol (110) with (108) catalyzed by base provides thiophene (112). Debenzylation with boron tribromide gives thiophene (114). Hydrolysis and protonation provide Example (17).

Scheme 18

The following scheme illustrates a process for making Example (18), a 5-substituted 1,2,3,4-thiatriazole LTB_4 receptor antagonist:

Scheme 18



(30) (116) (118) (120) (122) (124) (18)

Reference for formation of dithioacids: N. C. Gonnella et al. Syn. Commun. 1979, 17

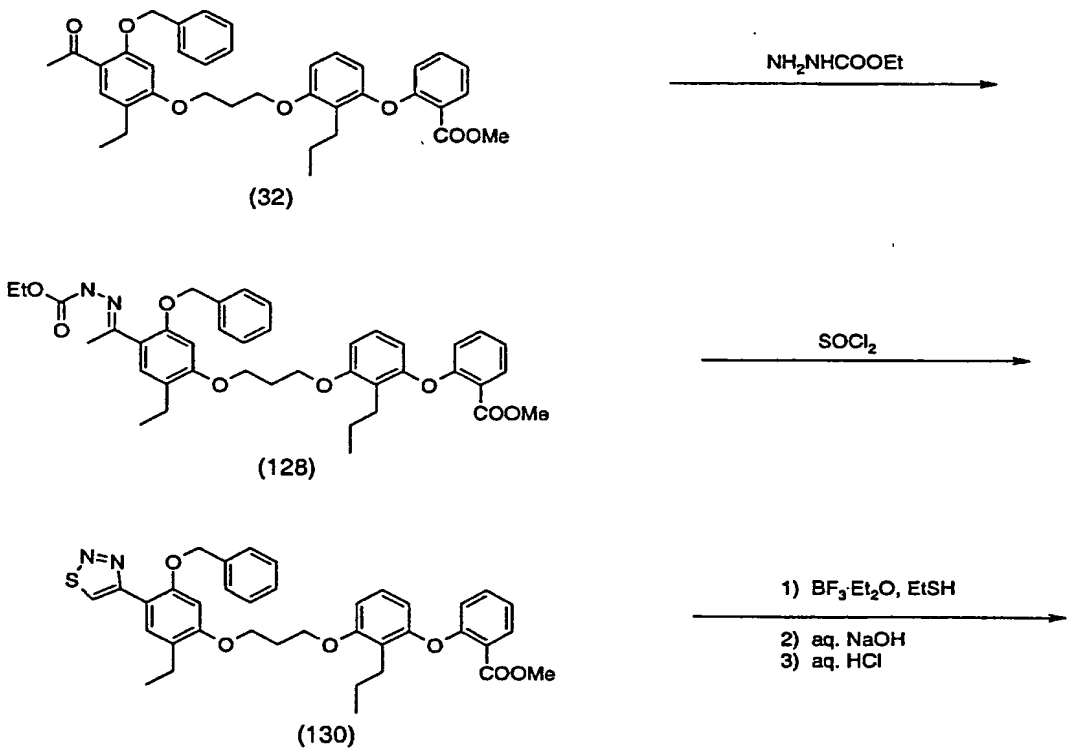
Reference for formation of 5-substituted 1,2,3,4-thiatriazoles from dithioacids: S. I. Ikeda et al., Synthesis 1990, 415

Phenol (30) is alkylated with 1-bromo-3-chloropropane to give chloride (116), that is in turn to be treated with known aldehyde (118) and a base, followed by benzylation with benzyl bromide and a base, to provide aldehyde (120). From aldehyde (120) is made the thioacetal by treatment with 1,2-ethanedithiol. The resulting thioacetal is then to be treated with base to provide the thioacid. Treatment with piperidine makes piperidinium salt (122). By the teaching of Ikeda, infra, (the disclosure of which is incorporated herein by reference) treatment of (122) with 2-chloropyridinium methyl iodide followed by azide ion will give the 1,2,3,4-thiatriazole (124). Debenzylation with boron trifluoride etherate and ethanethiol, followed by hydrolysis and protonation, will provide the product of Example (18).

Scheme 19

The following scheme illustrates a process for making Example (19), a 4-substituted 1,2,3-thiadiazole LTB_4 receptor antagonist:

Scheme 19



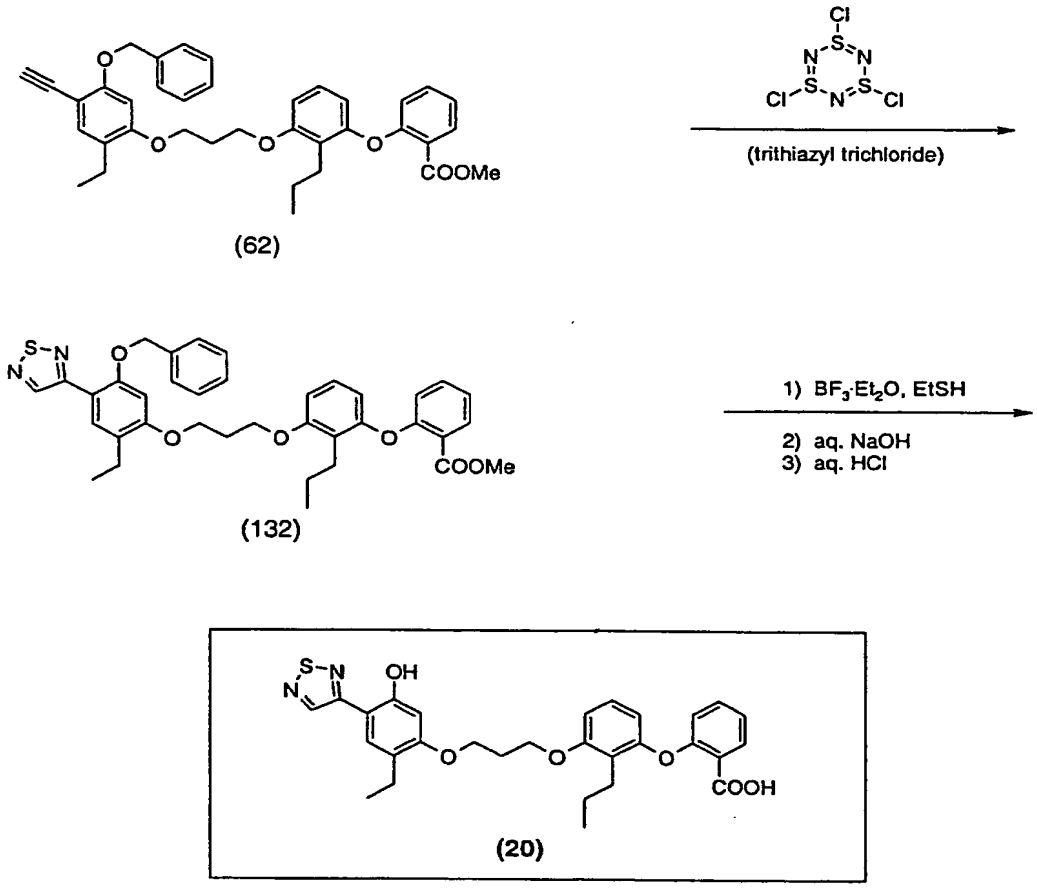
Reference for 1,2,3-thiadiazole formation: E. W. Thomas et al., J. Med. Chem. 1985, *28*, 442.

Treatment of acetophenone (32) with ethyl carbazate will give the hydrazone (128). Use of thionyl chloride by the method of Thomas et. al. (infra., the disclosure of which is incorporated herein by reference) will give an intermediate 1,2,3-thiadiazole (130), that is to be debenzylated with boron trifluoride etherate and ethanethiol, then hydrolyzed and protonated to give the product of Example (19).

Scheme 20

The following scheme illustrates a process for making Example (20), a 3-substituted 1,2,5-thiadiazole LTB_4 receptor antagonist:

Scheme 20



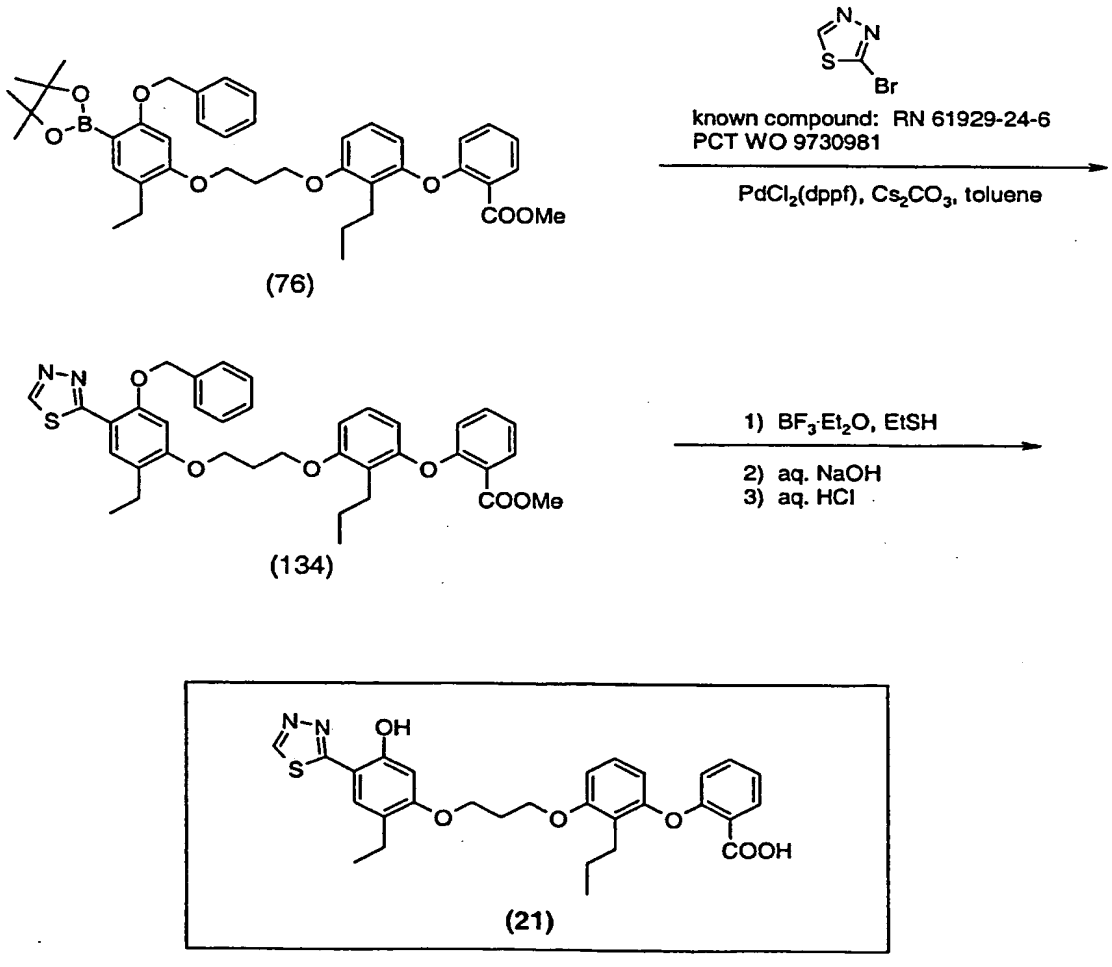
Reference for 1,2,5-thiadiazole formation: E. W. Thomas et al., J. Med. Chem. 1985, *28*, 442.

Alkyne (62) is to be treated with trithiazyl trichloride by the method of Thomas et. al. (infra., the disclosure of which is incorporated herein by reference) to provide thiadiazole (132). Debenzylation with boron trifluoride etherate and ethanethiol, followed by hydrolysis and protonation, will provide the product of Example (20).

Scheme 21

The following scheme illustrates a process for making Example (21), a 2-substituted 1,3,4-thiadiazole LTB_4 receptor antagonist:

Scheme 21

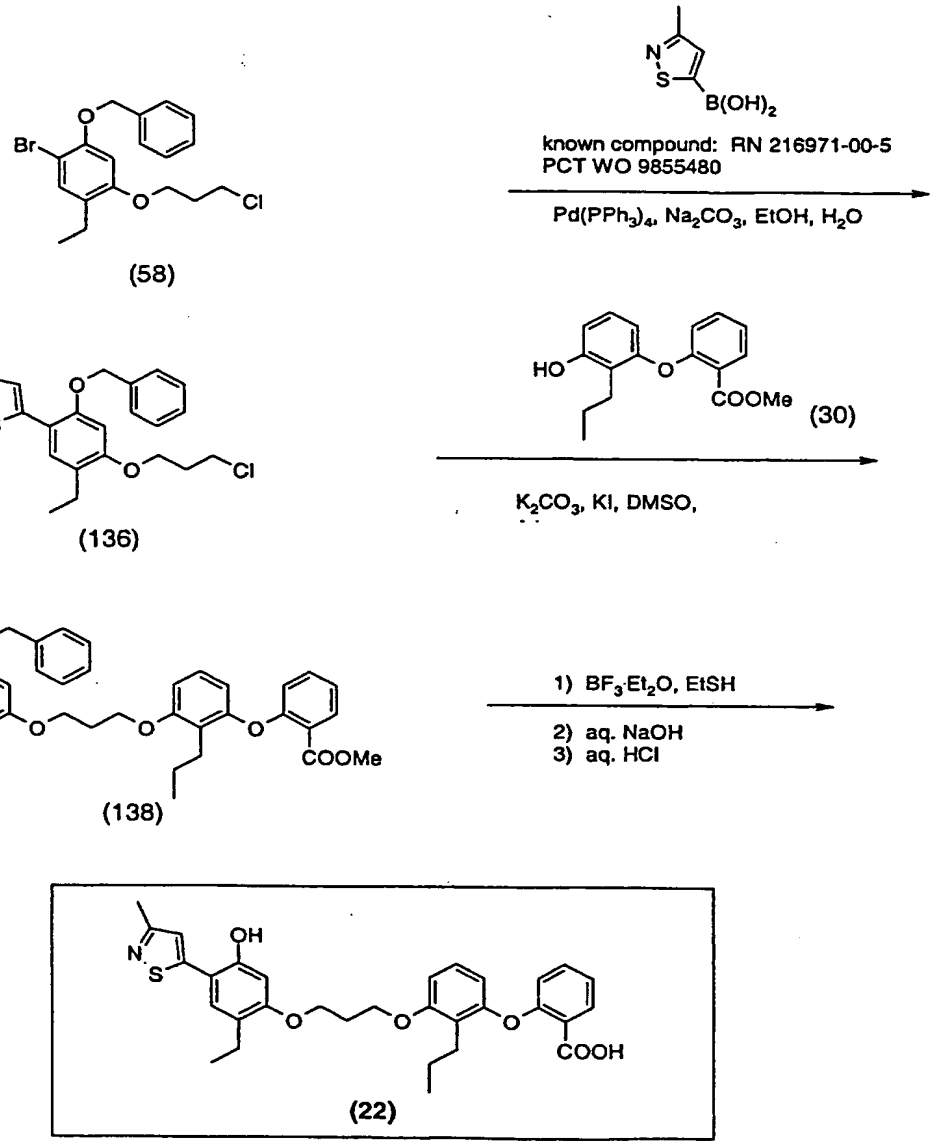


The palladium-catalyzed addition of boronic ester (76) to 2-bromo-1,3,4-thiadiazole will provide ester (134). Debenzylation with boron trifluoride etherate and ethanethiol, followed by hydrolysis and protonation, will provide the product of Example (21).

Scheme 22

The following scheme illustrates a process for making Example (22), a 5-substituted isothiazole LTB_4 receptor antagonist:

Scheme 22

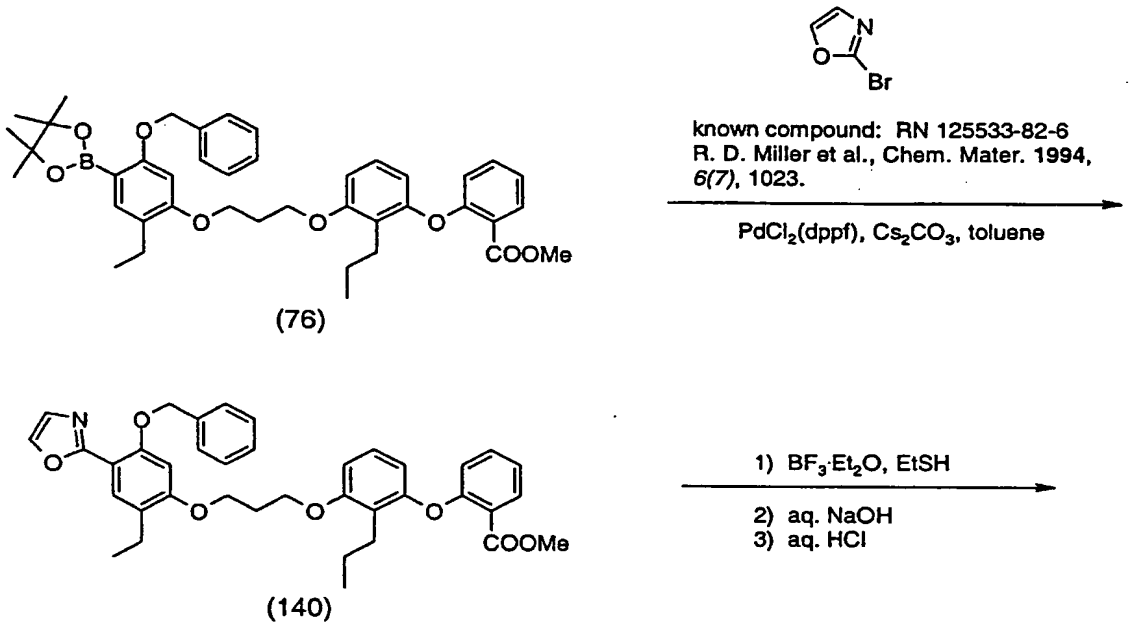


The palladium-catalyzed addition of bromide (58) to 3-methylisothiazole-5-boronic acid will provide isothiazole (136). Alkylation of phenol (30) with (136) catalyzed by base will provide isothiazole (138). Debenzylation with boron trifluoride etherate and ethanethiol, followed by hydrolysis and protonation, will provide the product of Example (22).

Scheme 23

The following scheme illustrates a process for making Example (23), a 2-substituted oxazole LTB_4 receptor antagonist:

Scheme 23



The palladium-catalyzed addition of boronic ester (76) to 2-bromooxazole will provide oxazole (140). Debenzylation with boron trifluoride etherate and ethanethiol, followed by hydrolysis and protonation, will provide the product of Example (23).

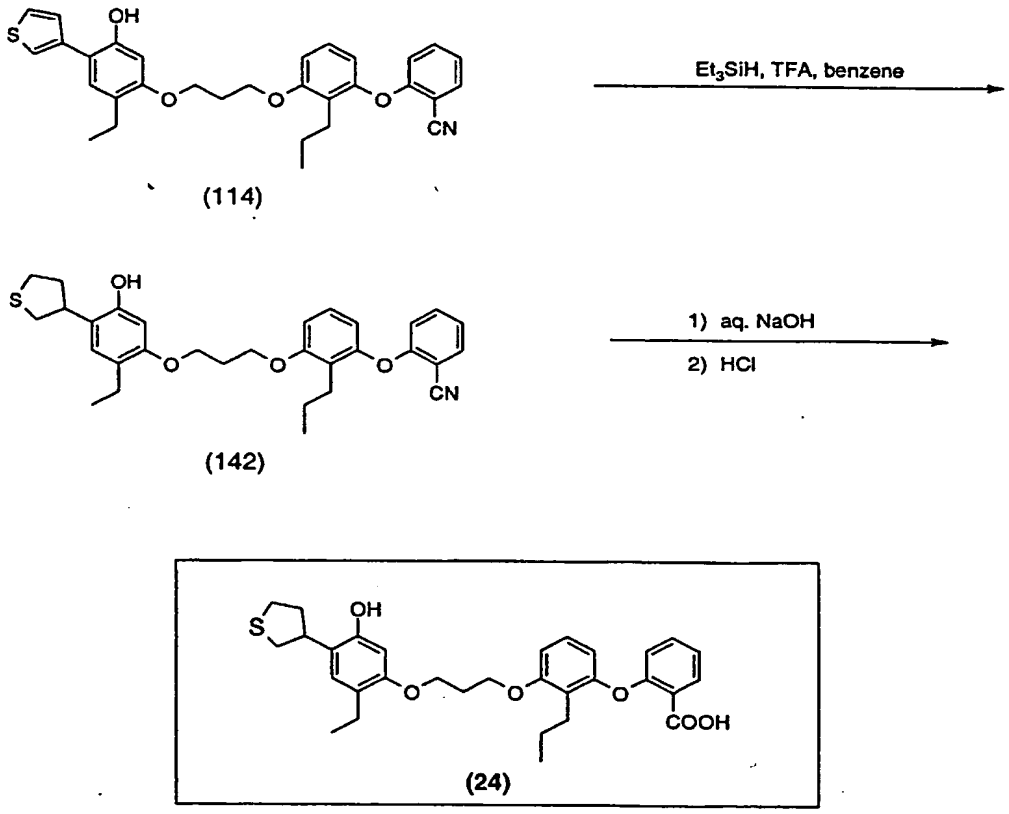
Scheme 24

The following scheme illustrates a process for making Example (24), a 3-substituted thiophane LTB_4 receptor antagonist:

5

10

Scheme 24



Reference for formation of tetrahydrothiophenes: D. N. Kursanov et al. Tetrahedron 1975, *31*, 311

Thiophene (114) may be reduced in the presence of triethylsilane and trifluoroacetic acid by the method of Kursanov et. al. (infra., the disclosure of which is incorporated herein by reference) to provide the thiophane (142). Hydrolysis and protonation will provide the product of Example (24).

V. PREPARATIVE EXAMPLES 1 TO 17:

Example 1

Preparation of 2-{3-[3-(2-Ethyl-5-hydroxy-4-oxazol-4-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid.

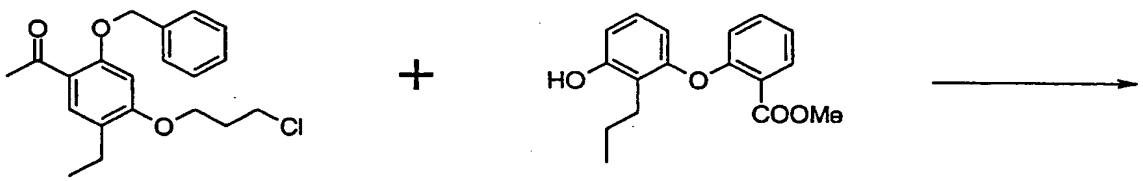
known compound: RN# 156005-61-7
R. W. Harper et al., J. Med. Chem. **1994**, *37(15)*, 2411-20

A. Preparation of 1-[2-benzyloxy-4-(3-chloropropoxy)-5-ethylphenyl]ethanone.

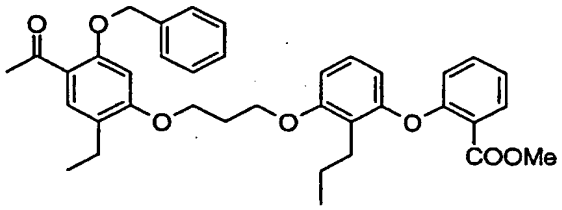
A mixture of 1-[2-hydroxy-4-(3-chloropropoxy)-5-ethylphenyl]ethanone (26.1 g, 102 mmol), cesium carbonate (33.4 g, 103 mmol), and benzyl bromide (12.2 ml, 103 mmol), in N,N-dimethylformamide (300 mL) was stirred for 5 h at room temperature. The mixture was diluted with ethyl acetate and washed four times with water. The organic layer was dried (sodium sulfate), filtered, and concentrated in vacuo. The resulting oil was triturated with ethyl acetate and hexane, allowed to stand for 18 h, then cooled at 0 °C for 3 h. The resulting precipitate was collected via vacuum filtration to provide 24.3 g (69%) of the title compound as white crystals: mp 60-61 °C. ^{1}H NMR ($CDCl_3$) δ 7.68 (s, 1H), 7.40 (m, 5H), 6.48 (s, 1H), 5.17 (s, 2H), 4.13 (t, J =

6 Hz, 2H), 3.75 (t, J = 6 Hz, 2H), 2.56 (s, 3H), 2.55 (q, J = 7 Hz, 2H), 2.26 (quintet, J = 6 Hz, 2H), 1.16 (t, J = 7 Hz, 3H); TOF MS ES^+ exact mass calculated for $C_{20}H_{24}ClO_3$ (p+1): m/z = 347.1414. Found: 347.1402; IR ($CHCl_3$, cm^{-1}) 1659, 1602, 1266.

Anal. Calcd for $C_{20}H_{23}ClO_3$: C, 69.26; H, 6.68. Found: C, 69.30; H, 6.52.



known compound: RN# 152609-76-2
J. S. Sawyer et al., J. Med. Chem. **1995**, *38*, 4411

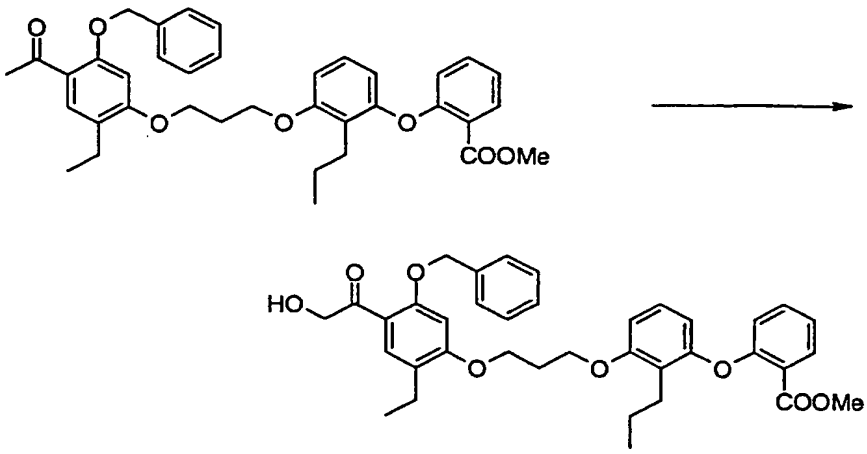


B. Preparation of 2-{3-[3-(4-acetyl-5-benzyloxy-2-ethylphenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester.

A mixture of 1-[2-benzyloxy-4-(3-chloropropoxy)-5-ethylphenyl]ethanone (7.27 g, 21.0 mmol) and sodium iodide (3.14 g, 23.1 mmol) in 2-butanone (100 mL) was heated at reflux for 18 h. The mixture was cooled to room temperature, filtered, and concentrated in vacuo. The

residue was dissolved in N,N-dimethylformamide (100 mL) and treated with 2-(3-hydroxy-2-propylphenoxy)benzoic acid methyl ester (6.0 g, 21 mmol) and potassium carbonate (3.2 g, 23 mmol) at room temperature for 15 h. The mixture was diluted with ethyl acetate and washed four times with water and once with saturated sodium chloride solution. The organic layer was dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 9.2 g (72%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.88 (d, J = 9 Hz, 1H), 7.69 (s, 1H), 7.38 (m, 6H), 7.12 (d, J = 8 Hz, 1H), 7.07 (d, J = 8 Hz, 1H), 6.80 (d, J = 8 Hz, 1H), 6.67 (d, J = 8 Hz, 1H), 6.50 (s, 1H), 6.44 (d, J = 9 Hz, 1H), 5.14 (s, 2H), 4.20 (m, 4H), 3.83 (s, 3H), 2.65 (t, J = 7 Hz, 2H), 2.57 (q, J = 7 Hz, 2H), 2.56 (s, 3H), 2.32 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 7 Hz, 2H), 1.15 (t, J = 8 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); IR ($CHCl_3$, cm^{-1}) 2965, 1726, 1602, 1461.

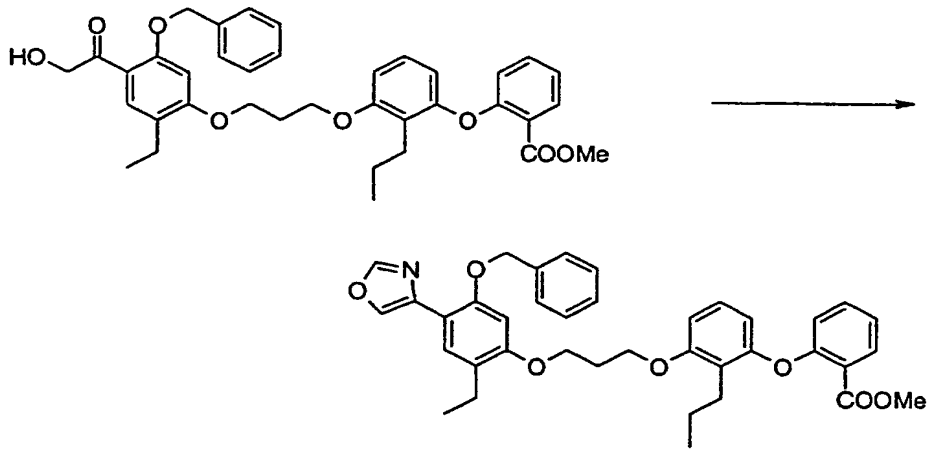
Anal. Calcd for $C_{37}H_{40}O_7$: C, 74.48; H, 6.76. Found: C, 74.39; H, 6.77.



C. Preparation of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(2-hydroxyacetyl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A mixture of 2-{3-[3-(4-acetyl-5-benzyloxy-2-ethylphenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester (5.31 g, 8.89 mmol) and water (10 mL) in acetonitrile (50 mL) was treated with trifluoroacetic acid (1.4 mL), 18 mmol) and [bis(trifluoroacetoxy)iodo]benzene (7.65 g, 17.8 mmol). The resulting mixture was heated at reflux for 4 h then concentrated in vacuo. The residue was dissolved in methylene chloride and washed once with water. The aqueous layer was extracted twice with fresh portions of methylene chloride. The combined organic layers were washed three times with saturated sodium bicarbonate solution, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 20% ethyl acetate/80% hexane) of the residue provided 1.68 g (31%) of the title compound as a brown oil. ^{1}H NMR ($CDCl_3$) δ 7.92 (s, 1H), 7.88 (d, J = 9 Hz, 1H), 7.40 (m,

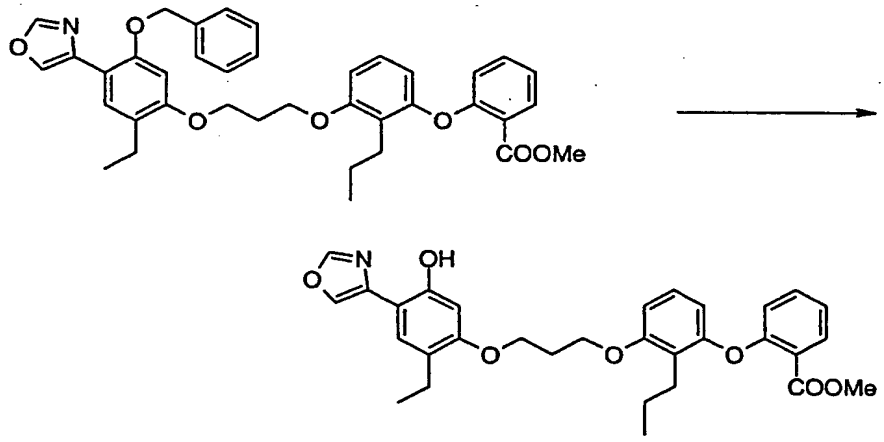
6H), 7.12 (d, J = 9 Hz, 1H), 7.05 (d, J = 9 Hz, 1H), 6.79 (d, J = 8 Hz, 1H), 6.66 (d, J = 8 Hz, 1H), 6.50 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 5.15 (s, 2H), 4.65 (s, 2H), 4.22 (m, 4H), 3.83 (s, 3H), 2.65 (m, 4H), 2.34 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 7 Hz, 2H), 1.17 (t, J = 8 Hz, 3H), 0.89 (t, J = 8 Hz, 3H); TOS MS ES^+ exact mass calculated for $C_{37}H_{41}O_8$ (p+1): m/z = 613.2801. Found: 613.2833.



D. Preparation of 2-{3-[3-(5-benzyloxy-2-ethyl-4-oxazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

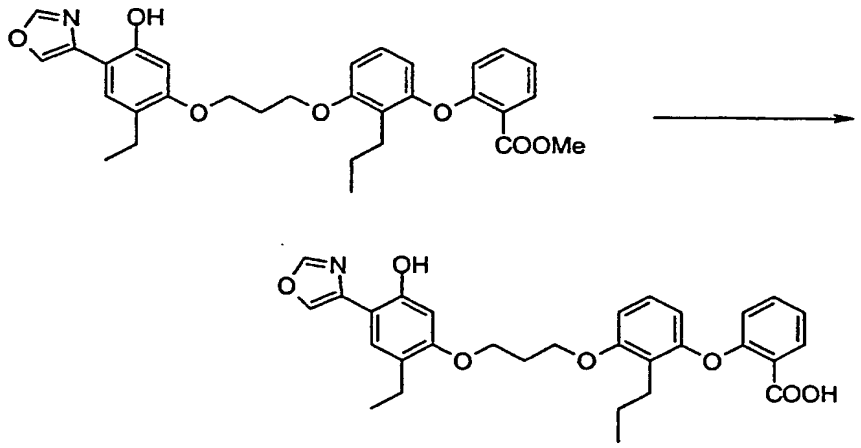
To a solution of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(2-hydroxyacetyl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (1.39 g, 2.27 mmol) in methylene chloride (20 mL) cooled to -78 °C was added triflic anhydride (0.57 mL, 3.4 mmol) and 2,6-lutidine (0.40 mL, 3.4 mmol). The resulting mixture was stirred for 1 h then poured into ether and water. The organic layer was separated and washed once with saturated sodium chloride solution, dried (sodium

sulfate), filtered, and concentrated in vacuo. The residue was dissolved in a 2:1 mixture of formamide/N,N-dimethylformamide (9 mL) and heated at 120 °C in a sealed tube for 4 h. The mixture was cooled to room temperature and diluted with ethyl acetate. The mixture was washed four times with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 89 mg (6%) of the title product as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.92 (s, 1H), 7.85 (s, 1H), 7.83 (m, 2H), 7.35 (m, 6H), 7.03 (d, J = 8 Hz, 1H), 7.00 (d, J = 8 Hz, 1H), 6.73 (d, J = 8 Hz, 1H), 6.62 (d, J = 8 Hz, 1H), 6.52 (s, 1H), 6.35 (d, J = 8 Hz, 1H), 5.07 (s, 2H), 4.14 (m, 4H), 3.76 (s, 3H), 2.61 (m, 4H), 2.26 (quintet, J = 6 Hz, 2H), 1.48 (hextet, J = 7 Hz, 2H), 1.15 (t, J = 8 Hz, 3H), 0.84 (t, J = 8 Hz, 3H).



E. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-oxazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

To a solution of 2-{3-[3-(5-benzyloxy-2-ethyl-4-oxazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (89 mg, 0.14 mmol) in ethanethiol (2 mL) was treated with boron trifluoride etherate (0.27 mL, 2.2 mmol) at room temperature for 4 h. The solution was poured into ether and washed once with water, once with saturated sodium bicarbonate solution, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 15% ethyl acetate/85% hexane) of the residue provided 34 mg (45%) of the title product as a light brown oil. ^{1}H NMR ($CDCl_3$) δ 7.99 (d, J = 1 Hz, 1H), 7.90 (d, J = 1 Hz, 1H), 7.88 (dd, J = 8, 2 Hz, 1H), 7.38 (t, J = 7 Hz, 1H), 7.15 (s, 1H), 7.10 (d, J = 9 Hz, 1H), 7.06 (d, J = 9 Hz, 1H), 6.81 (d, J = 9 Hz, 1H), 6.70 (d, J = 9 Hz, 1H), 6.52 (s, 1H), 6.44 (d, J = 9 Hz, 1H), 4.20 (m, 4H), 3.83 (s, 3H), 2.65 (t, J = 8 Hz, 2H), 2.58 (q, J = 8 Hz, 2H), 2.33 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 7 Hz, 2H), 1.17 (t, J = 8 Hz, 3H), 0.91 (t, J = 8 Hz, 3H); MS ES+ m/e = 532 (p + 1).



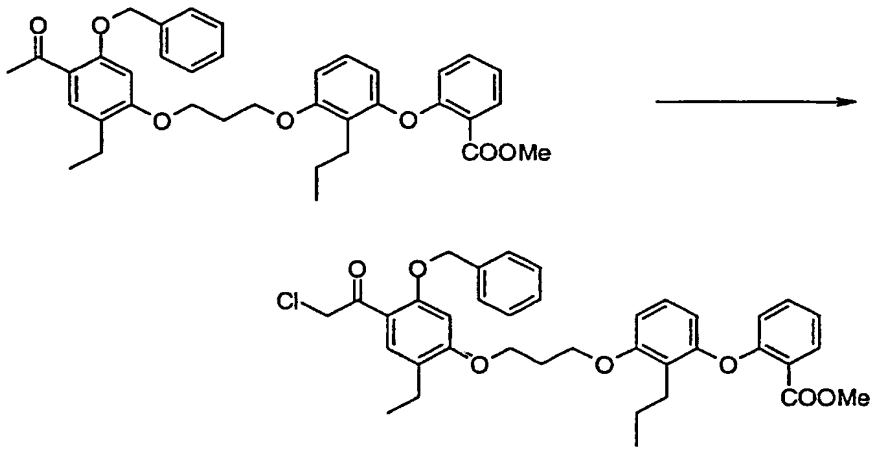
F. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-oxazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid.

To a solution of 2-{3-[3-(2-ethyl-5-hydroxy-4-oxazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (89 mg, 0.14 mmol) in methanol (2 mL) was added 1 M lithium hydroxide solution (0.28 mL) and the resulting mixture warmed at 60 °C for 3.5 h. The mixture was cooled to room temperature and concentrated in vacuo. The aqueous residue was diluted with water and the pH adjusted to ~4. The mixture was extracted three times with methylene chloride. The combined organic extracts were dried (sodium sulfate), filtered, and concentrated in vacuo to provide 27 mg (92%) of the title compound as a yellow solid. ^{1}H NMR (DMSO-d_6) δ 12.83 (bs, 1H), 10.12 (bs, 1H), 8.39 (s, 1H), 8.25 (s, 1H), 7.78 (dd, J = 8, 1 Hz, 1H), 7.64 (s, 1H), 7.47 (t, J = 8 Hz, 1H), 7.16 (m, 2H), 6.80 (t, J = 8 Hz, 2H), 6.56 (s, 1H), 6.35 (d, J = 8 Hz, 1H), 4.20 (t, J = 6 Hz, 2H), 4.12 (t, J = 6 Hz, 2H); 2.54 (m, 4H), 2.24 (quintet, J = 6 Hz, 2H), 1.43 (hextet, J = 8 Hz, 2H), 1.10 (t, J = 8 Hz, 3H), 0.80 (t, J = 8 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{30}H_{32}NO_7$ (p+1): m/z = 518.2179. Found: 518.2206; IR (KBr, cm^{-1}) 2961, 1696, 1460, 1222.

Anal. Calcd for $C_{30}H_{31}NO_7$: C, 69.62; H, 6.04; N, 2.71. Found: C, 68.71; H, 5.82; N, 2.65.

Example 2

Preparation of 2-(3-{3-[2-Ethyl-5-hydroxy-4-(3*H*-imidazol-4-yl)phenoxy]propoxy}-2-propyl-phenoxy)benzoic acid hydrochloride.

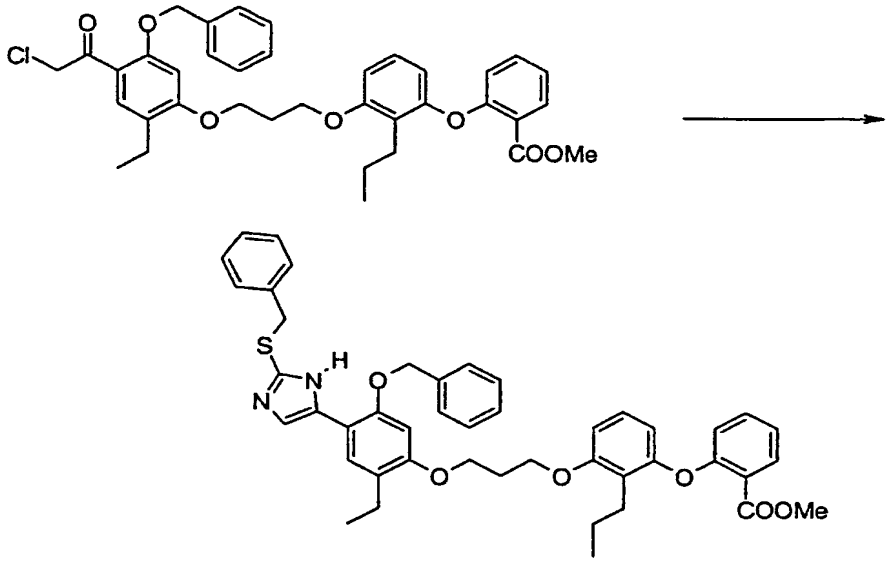


A. Preparation of 2-(3-{3-[5-benzyloxy-4-(2-chloroacetyl)-2-ethylphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester.

To a solution of 2-{3-[3-(4-acetyl-5-benzyloxy-2-ethylphenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester (3.04 g, 5.09 mmol) in tetrahydrofuran (50 mL) cooled to -78 °C was added a solution of 1 M lithium hexamethyldisilazide in tetrahydrofuran (11.2 mL, 11.2 mmol) portion wise. After stirring for 20 min, trimethylsilyl chloride (2.6 mL, 20 mmol) was added and the mixture warmed to 0 °C and stirred for 30 min. The mixture was evaporated in vacuo and the residue dissolved in hexane. The resulting solution was filtered and concentrated in vacuo. The residue was dissolved in tetrahydrofuran (50 mL), cooled to

0 °C, and treated with N-chlorosuccinimide (750 mg, 5.6 mmol). The mixture was warmed to room temperature and stirred for 30 min, then heated at reflux for 2 h. The mixture was cooled to room temperature and treated with water (4 mL) and a solution of 1 N tetra-n-butylammonium fluoride in tetrahydrofuran (6 mL). After stirring for 15 min the mixture was diluted in ether and washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 1.94 g (60%) of the title compound as a white solid. ^{1}H NMR ($CDCl_3$) δ 7.89 (d, J = 8 Hz, 1H), 7.77 (s, 1H), 7.40 (m, 6H), 7.12 (d, J = 9 Hz, 1H), 7.06 (d, J = 8 Hz, 1H), 6.80 (d, J = 8 Hz, 1H), 6.66 (d, J = 8 Hz, 1H), 6.49 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 5.15 (s, 2H), 4.68 (s, 2H), 4.20 (q, J = 6 Hz, 4H), 3.82 (s, 3H), 2.65 (t, J = 7 Hz, 2H), 2.59 (q, J = 7 Hz, 2H), 2.32 (quintet, J = 6 Hz, 2H), 1.54 (hextet, J = 8 Hz, 2H), 1.16 (t, J = 8 Hz, 3H), 0.89 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{37}H_{40}ClO_7$ (p+1): m/z = 631.2463. Found: 631.2470; IR ($CHCl_3$, cm^{-1}) 2964, 1720, 1603, 1461.

Anal. Calcd for $C_{37}H_{39}ClO_7$: C, 70.41; H, 6.23. Found: C, 70.04; H, 5.97.

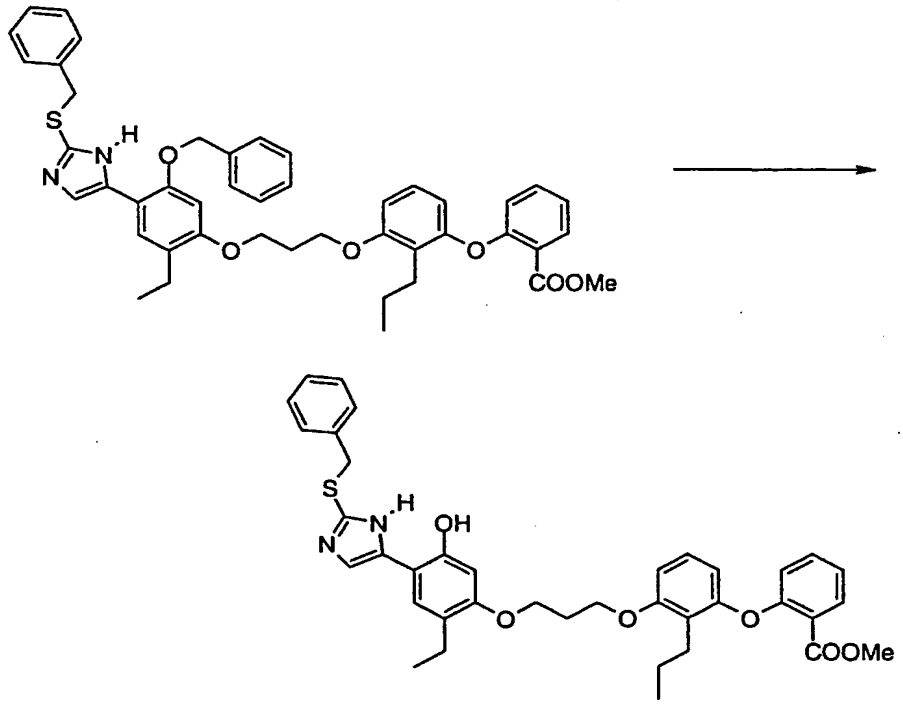


B. Preparation of 2-(3-{3-[5-benzyloxy-4-(2-benzylsulfanyl-3*H*-imidazol-4-yl)-2-ethyl-phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A mixture of 2-(3-{3-[5-benzyloxy-4-(2-chloroacetyl)-2-ethylphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (800 mg, 1.27 mmol), 2-benzyl-2-thiopseudourea hydrochloride (313 mg, 1.52 mmol), sodium iodide (77 mg, 0.51 mmol), and potassium carbonate (700 mg, 5.06 mmol) in N,N-dimethylformamide (20 mL) was treated at 80 °C for 6 h. The mixture was cooled, diluted with diethyl ether, and washed once with water. The organic layer was dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 30% ethyl acetate/70% hexane) of the residue provided 376 mg (40%) of the title compound as a yellow amorphous solid. ^{1}H NMR ($CDCl_3$) δ 7.89 (d, J = 8 Hz, 1H), 7.36 (m, 9H), 7.20 (m, 5H), 7.21 (d, J = 9 Hz, 1H), 7.06 (d, J = 8 Hz, 1H), 6.79 (d, J = 8 Hz, 1H), 6.67 (d, J =

8 Hz, 1H), 6.55 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 5.07 (s, 2H), 4.21 (t, J = 6 Hz, 2H), 4.18 (t, J = 6 Hz, 2H), 4.10 (s, 2H), 3.83 (s, 3H), 2.63 (m, 4H), 2.31 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 7 Hz, 2H), 1.18 (t, J = 8 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); TOF MS ES^+ exact mass calculated for $C_{45}H_{47}N_2O_6S$ (p+1): m/z = 743.3155. Found: 743.3142; IR ($CHCl_3$, cm^{-1}) 2963, 1720, 1602, 1453.

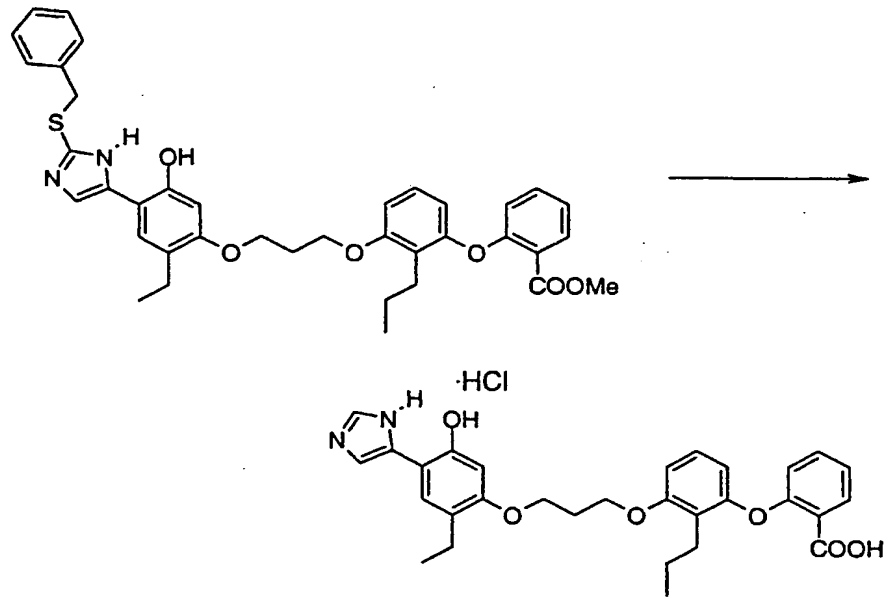
Anal. Calcd for $C_{45}H_{46}N_2O_6S$: C, 72.75; H, 6.24; N, 3.77. Found: C, 72.69; H, 6.17; N, 3.56.



C. Preparation of 2-(3-{3-[4-(2-benzylsulfanyl-3*H*-imidazol-4-yl)-2-ethyl-5-hydroxyphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A solution of 2-(3-{3-[5-benzyloxy-4-(2-benzylsulfanyl-3*H*-imidazol-4-yl)-2-ethyl-phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (360 mg, 0.49 mmol) in ethanethiol (7 mL) was treated with boron trifluoride etherate at room temperature for 3.5 h. The mixture was diluted with diethyl ether and water. The organic layer was separated and washed with saturated sodium bicarbonate solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 20% ethyl acetate/80% hexane) of the residue provided 154 mg (48%) of the title compound as an orange oil. ^{1}H NMR ($CDCl_3$) δ 7.85 (d, J = 8 Hz, 1H), 7.36 (t, J = 7 Hz, 1H), 7.20 (m, 7H), 7.12 (s, 1H), 7.05 (m, 3H), 6.79 (d, J = 8 Hz, 1H), 6.65 (d, J = 8 Hz, 1H), 6.54 (s, 1H), 6.41 (d, J = 8 Hz, 1H), 4.20 (s, 2H), 4.17 (m, 4H), 3.82 (s, 3H), 2.62 (t, J = 8 Hz, 2H), 2.54 (q, J = 7 Hz, 2H), 2.30 (quintet, J = 6 Hz, 2H), 1.53 (hextet, J = 8 Hz, 2H), 1.14 (t, J = 7 Hz, 3H), 0.89 (t, J = 8 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{38}H_{41}N_2O_6S$ (p+1): m/z = 653.2685. Found: 653.2669.

Anal. Calcd for $C_{38}H_{40}N_2O_6S$: C, 69.92; H, 6.18; N, 4.29. Found: C, 69.44; H, 6.25; N, 3.99.



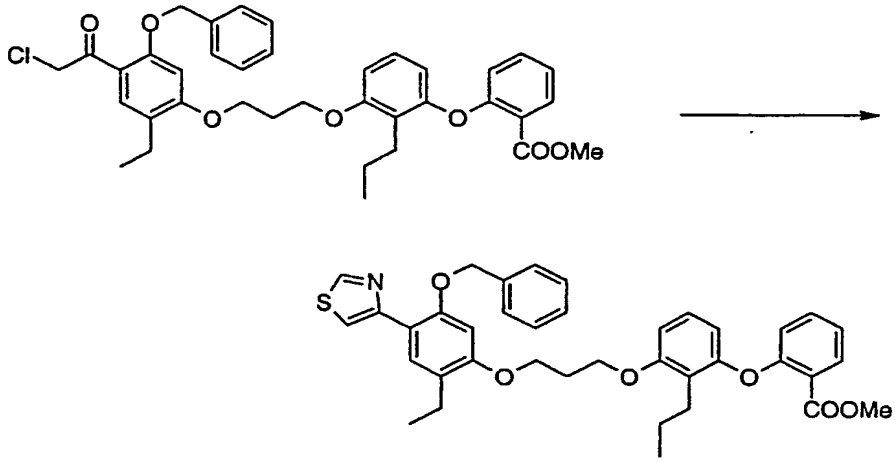
D. Preparation of 2-(3-{3-[2-ethyl-5-hydroxy-4-(3H-imidazol-4-yl)phenoxy]propoxy}-2-propyl-phenoxy)benzoic acid hydrochloride.

A solution of 2-(3-{3-[4-(2-benzylsulfanyl-3*H*-imidazol-4-yl)-2-ethyl-5-hydroxyphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (154 mg, 0.235 mmol) in methanol (3 mL) was treated with 1 N lithium hydroxide solution at 60 °C for 3.5 h. The mixture was cooled to room temperature and concentrated in vacuo. The solution was diluted with water and adjusted to pH 4. The aqueous solution was extracted three times with methylene chloride. The combined organic layers were dried (sodium sulfate), filtered, and concentrated in vacuo. The residue was dissolved in ethanol (3 mL) and treated with 0.2 N sodium hydroxide solution (1 mL) and Raney nickel (75 mg) at 75 °C for 4 h. The mixture was cooled to room temperature,

filtered through Celite™, and the filtrate concentrated in vacuo. The residue was diluted with water and adjusted to pH 2 with 1 N hydrochloric acid. The resulting precipitate was collected via vacuum filtration to provide 27 mg (21%) of the title compound. TOF MS ES^+ exact mass calculated for $C_{30}H_{33}N_2O_6$ (p+1): m/z = 517.2339. Found: 517.2340.

Example 3

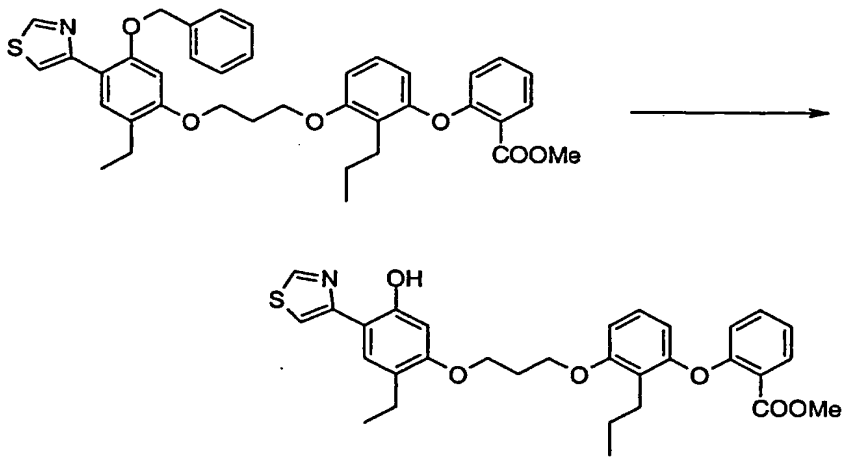
Preparation of 2-{3-[3-(2-Ethyl-5-hydroxy-4-thiazol-4-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid.



A. Preparation of 2-{3-[3-(5-benzyloxy-2-ethyl-4-thiazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

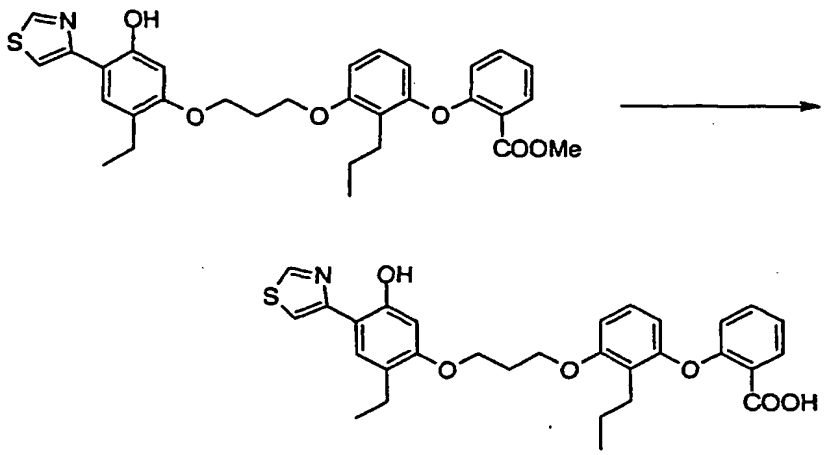
A mixture of 2-(3-{3-[5-benzyloxy-4-(2-chloroacetyl)-2-ethylphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (500 mg, 0.792 mmol), thioformamide (20 mL, 8.0 mmol), and magnesium carbonate in dioxane (10 mL) was heated at

reflux for 2 h. The mixture was cooled to room temperature and diluted with diethyl ether and 0.2 M sodium hydroxide solution. The organic layer was separated, washed with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 254 mg (50%) of the title compound as a colorless oil. ^1H NMR ($CDCl_3$) δ 8.91 (s, 1H), 8.11 (s, 1H), 7.87 (dd, J = 8, 1 Hz, 1H), 7.84 (d, J = 1 Hz, 1H), 7.40 (m, 6H), 7.08 (m, 2H), 6.80 (d, J = 8 Hz, 1H), 6.68 (d, J = 8 Hz, 1H), 6.62 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 5.16 (s, 2H), 4.21 (t, J = 6 Hz, 4H), 3.83 (s, 3H), 2.68 (m, 4H), 2.32 (quintet, J = 6 Hz, 2H), 1.56 (hextet, J = 8 Hz, 2H), 1.21 (t, J = 7 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); TOF MS ES^+ exact mass calculated for $C_{38}H_{40}NO_6S$ (p+1): m/z = 638.2576. Found: 638.2579. IR ($CHCl_3$, cm^{-1}) 2964, 1719, 1563, 1461.



B. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-thiazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A solution of 2-{3-[3-(5-benzyloxy-2-ethyl-4-thiazol-4-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester (243 mg, 0.366 mmol) in ethanethiol (7 mL) was treated with boron trifluoride etherate at room temperature for 4 h. The mixture was diluted with diethyl ether, washed once with water, once with saturated sodium bicarbonate solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 15% ethyl acetate/85% hexane) of the residue provided 131 mg (65%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 8.88 (d, J = 1 Hz, 1H), 7.88 (dd, J = 8, 1 Hz, 1H), 7.44 (d, J = 1 Hz, 1H), 7.38 (m, 2H), 7.08 (m, 2H), 6.81 (d, J = 8 Hz, 1H), 6.68 (d, J = 8 Hz, 1H), 6.55 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 4.21 (t, J = 6 Hz, 4H), 3.83 (s, 3H), 2.63 (m, 4H), 2.33 (quintet, J = 6 Hz, 2H), 1.56 (hextet, J = 8 Hz, 2H), 1.19 (t, J = 8 Hz, 3H), 0.91 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{31}H_{34}NO_6S$ (p+1): m/z = 548.2107. Found: 548.2085.



C. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-thiazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid.

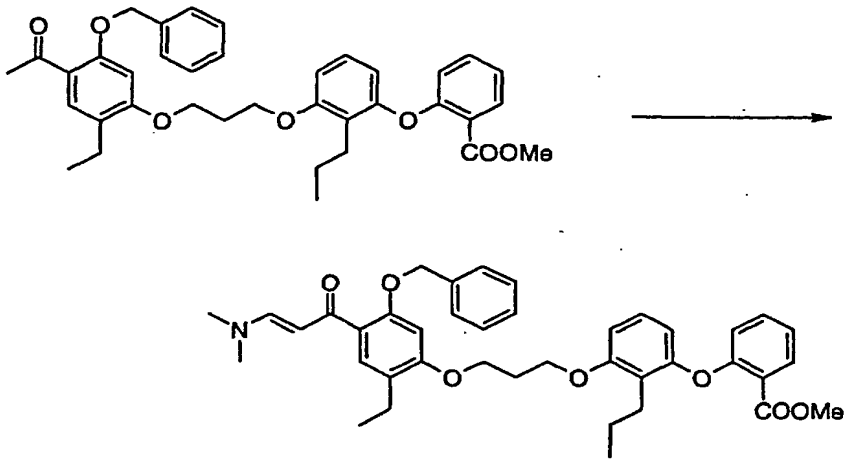
A solution of 2-{3-[3-(2-ethyl-5-hydroxy-4-thiazol-4-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (130 mg, 0.236 mmol) in methanol (4 mL) was treated with 1 M lithium hydroxide solution at 60 °C for 3 h. The mixture was cooled to room temperature, concentrated in vacuo, and diluted with water. The solution was adjusted to pH ~4 and extracted three times with methylene chloride. The combined organic layers were dried (sodium sulfate), filtered, and concentrated in vacuo. The residue was dissolved in a minimum of methylene chloride and hexane was added until the solution became cloudy. The mixture was concentrated slowly in vacuo to give 96 mg (76%) of the title compound. ^{1}H NMR ($CDCl_3$) δ 8.90 (s, 1H), 8.23 (dd, J = 8, 1 Hz, 1H), 7.41 (m, 2H), 7.38 (s, 1H), 7.29 (m, 2H), 6.82 (d, J = 8 Hz, 1H), 6.71 (d, J = 8 Hz, 1H), 6.62 (d, J = 8 Hz, 1H), 6.54 (s, 1H), 4.25 (t, J = 6 Hz, 2H), 4.22 (t, J = 6 Hz, 2H), 2.59

(m, 4H), 2.35 (quintet, J = 6 Hz, 2H), 1.50 (hextet, J = 8 Hz, 2H), 1.19 (t, J = 7 Hz, 3H), 0.88 (t, J = 8 Hz, 3H); TOF MS ES^+ exact mass calculated for $C_{30}H_{32}NO_6S$ (p+1): m/z = 534.1950. Found: 534.1957. IR ($CHCl_3$, cm^{-1}) 2965, 1738, 1454.

Anal. Calcd for $C_{30}H_{31}NO_6S$: C, 67.52; H, 5.86; N, 2.62. Found: C, 67.19; H, 5.72; N, 2.53.

Example 4

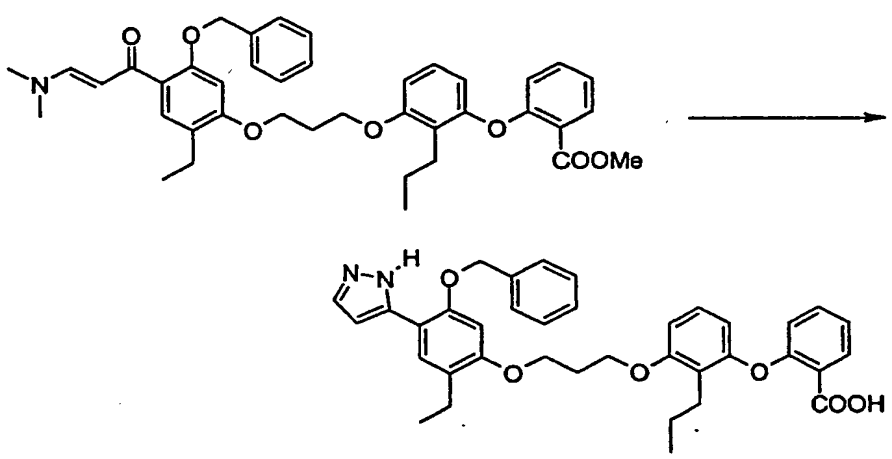
Preparation of 2-(3-{3-[2-Ethyl-5-hydroxy-4-(2*H*-pyrazol-3-yl)phenoxy]propoxy}-2-propyl-phenoxy)benzoic acid.



A. Preparation of 2-(3-{3-[5-benzyloxy-4-(3-dimethylaminoacryloyl)-2-ethyl-phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester.

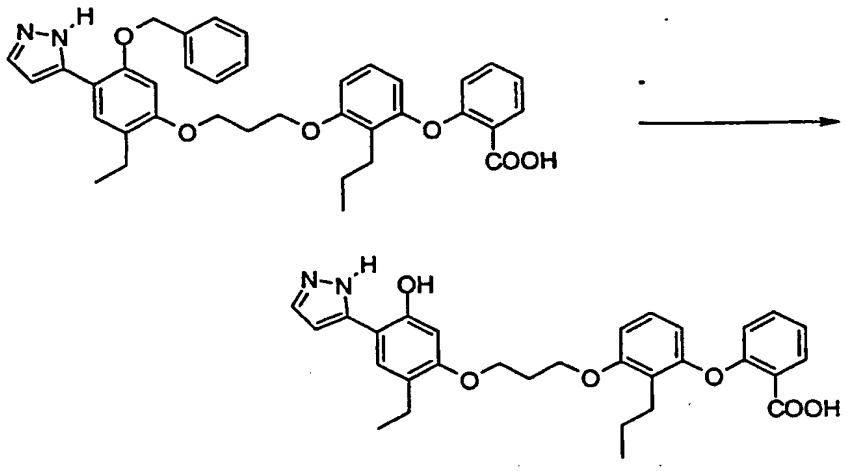
A mixture of 2-(3-{3-[4-acetyl-5-benzyloxy-2-ethylphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (3.07 g, 5.04 mmol) and dimethylformamide

dimethylacetal (0.9 mL, 7 mmol) in N,N-dimethylformamide (3 mL) was heated at 110-120 °C for 35 h. The mixture was cooled to room temperature and diluted with a mixture of ethyl acetate and 1 N hydrochloric acid. The organic layer was separated, washed twice with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 30% ethyl acetate/70% hexane to ethyl acetate) of the residue provided 2.1 g (63%) of the title compound as a yellow oil. TOF MS ES^+ exact mass calculated for $C_{40}H_{46}NO_7$ (p+1): m/z = 652.3274. Found: 652.3270. IR ($CHCl_3$, cm^{-1}) 2965, 1720, 1605. Anal. Calcd for $C_{40}H_{45}NO_7$: C, 73.71; H, 6.96; N, 2.15. Found: C, 73.72; H, 6.95; N, 2.18.



B. Preparation of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(2*H*-pyrazol-3-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid. A solution of 2-(3-{3-[5-benzyloxy-4-(3-dimethylaminoacryloyl)-2-ethyl-phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (550 mg, 0.843 mmol

in methanol (30 mL) was treated with 1 M lithium hydroxide solution at 60 °C for 3 h. The mixture was cooled to room temperature and diluted with ethyl acetate and 0.5 M hydrochloric acid. The organic layer was separated, washed with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. The residue was dissolved in methanol (15 mL) and treated with water (4 mL) and hydrazine monohydrate (0.50 mL, 7.7 mmol) at reflux for 3 h. The mixture was diluted with ethyl acetate and 1 N hydrochloric acid. The organic layer was separated, washed with saturated sodium chloride solution, dried (sodium sulfate), filtered and concentrated in vacuo. Chromatography (30% ethyl acetate/69% hexane/1% acetic acid) of the residue provided 350 mg (65%) of the title compound as the acetate salt. A portion of this material was free-based with sodium bicarbonate to provide an analytical sample. ^{1}H NMR ($CDCl_3$) δ 8.20 (dd, J = 8, 2 Hz, 1H), 7.55 (s, 1H), 7.44 (s, 1H), 7.38 (m, 5H), 7.15 (m, 2H), 6.78 (d, J = 8 Hz, 1H), 6.65 (d, J = 8 Hz, 1H), 6.61 (d, J = 8 Hz, 1H), 6.58 (s, 1H), 6.55 (bs, 1H), 5.18 (s, 2H), 4.22 (t, J = 6 Hz, 2H), 4.17 (t, J = 6 Hz, 2H), 2.58 (m, 4H), 2.30 (quintet, J = 6 Hz, 2H), 1.47 (hextet, J = 8 Hz, 2H), 1.18 (t, J = 7 Hz, 3H), 0.88 (t, J = 8 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{37}H_{39}N_2O_6$ (p+1): m/z = 607.2808. Found: 607.2831. IR ($CHCl_3$, cm^{-1}) 2965, 1739, 1604, 1454. Anal. Calcd for $C_{37}H_{38}N_2O_6$: C, 73.25; H, 6.31; N, 4.62. Found: C, 73.31; H, 6.30; N, 4.62.



C. Preparation of 2-(3-{3-[2-ethyl-5-hydroxy-4-(2*H*-pyrazol-3-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid.

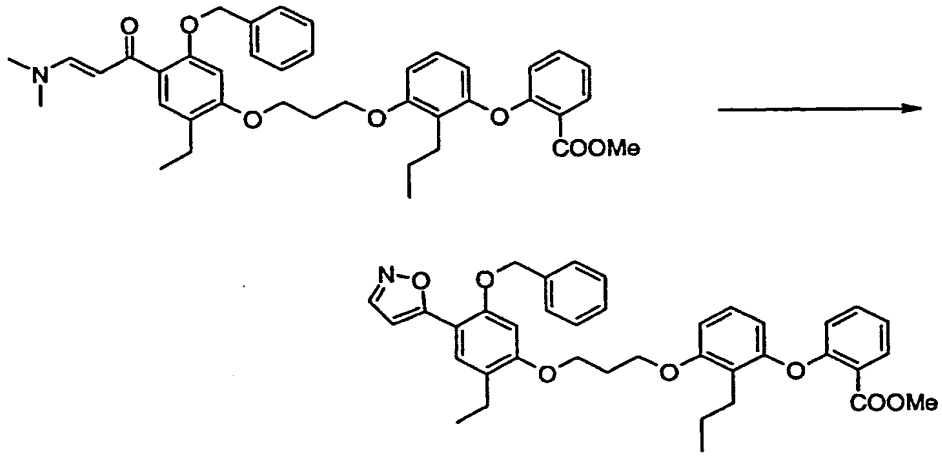
A solution of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(2*H*-pyrazol-3-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid (300 mg, 0.490 mmol) in ethanethiol (2.5 mL) was treated with boron trifluoride etherate (2 mL) at room temperature for 3 h, at which time an additional portion of boron trifluoride etherate (1 mL) was added and stirring resumed for an additional 1 h. The mixture was diluted with diethyl ether and water. The organic layer was separated, washed with water, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 15% ethyl acetate/85% hexane to 60% ethyl acetate/40% hexane) of the residue provided 60 mg (24%) of the title compound as a white solid. ^{1}H NMR ($CDCl_3$) δ 8.23 (d, J = 8 Hz, 1H), 7.61 (s, 1H), 7.42 (t, J = 7 Hz, 1H), 7.30 (s, 1H), 7.19 (d, J = 8 Hz, 1H), 7.15 (d, J = 8 Hz, 1H), 6.81 (d, J = 8 Hz, 1H), 6.69 (d, J = 8 Hz, 1H), 6.61 (s, 1H), 6.60 (d, J = 8 Hz, 1H), 6.54 (s, 1H), 4.20 (m, 4H), 2.58 (m, 4H), 2.33 (quintet, J = 6 Hz,

2H), 1.48 (hextet, J = 8 Hz, 2H), 1.17 (t, J = 8 Hz, 3H), 0.86 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{30}H_{33}N_2O_6$ (p+1): m/z = 517.2339. Found: 517.2334. IR ($CHCl_3$, cm^{-1}) 2965, 1738, 1454.

Anal. Calcd for $C_{30}H_{32}N_2O_6$: C, 69.75; H, 6.24; N, 5.42. Found: C, 69.73; H, 6.33; N, 5.25.

Example 5

Preparation of 2-{3-[3-(2-Ethyl-5-hydroxy-4-isoxazol-5-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid.

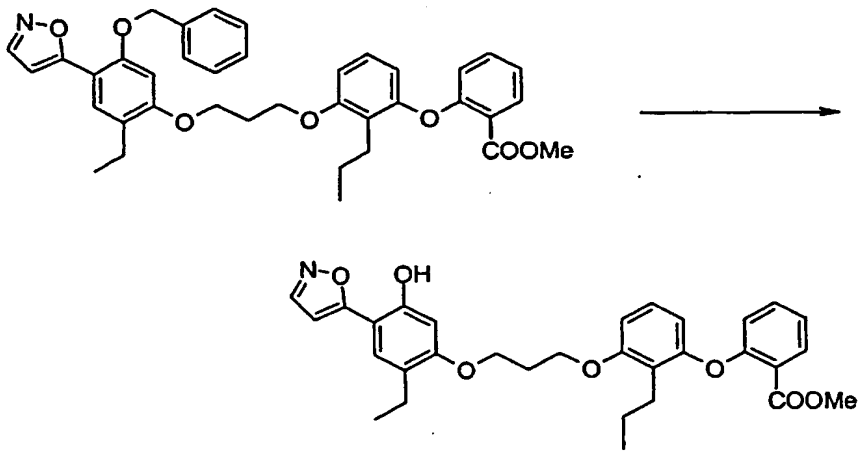


A. Preparation of 2-{3-[3-(5-benzyloxy-2-ethyl-4-isoxazol-5-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A mixture of 2-(3-{3-[5-benzyloxy-4-(3-dimethylaminoacryloyl)-2-ethylphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (280 mg, 0.43 mmol), hydroxylamine hydrochloride (75 mg, 1.1 mmol), and water (1

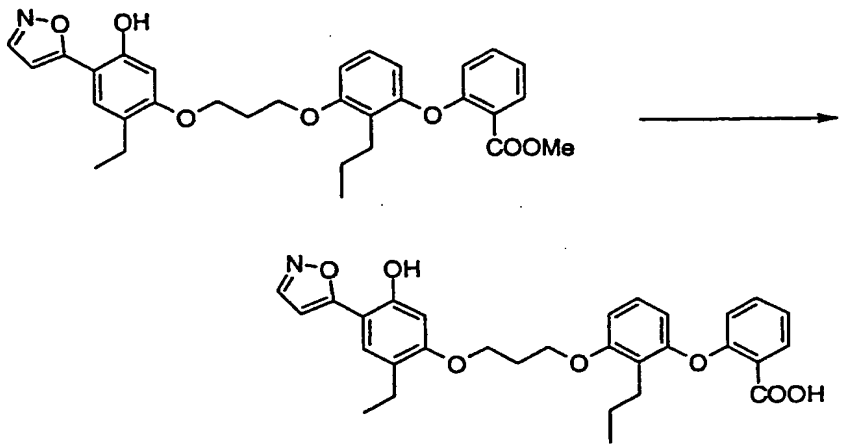
mL) in methanol (4 mL) was heated at reflux for 2 h. The mixture was cooled to room temperature and diluted with diethyl ether and water. The organic layer was separated, washed with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 202 mg (76%) of the title compound as a white solid. ^{1}H NMR ($CDCl_3$) δ 8.20 (d, J = 2 Hz, 1H), 7.88 (dd, J = 9, 2 Hz, 1H), 7.79 (s, 1H), 7.40 (m, 7H), 7.08 (m, 2H), 6.68 (d, J = 8 Hz, 1H), 6.59 (s, 1H), 6.58 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 5.15 (s, 2H), 4.21 (t, J = 6 Hz, 4H), 3.82 (s, 3H), 2.65 (m, 4H), 2.33 (quintet, J = 6 Hz, 2H), 1.56 (hextet, J = 8 Hz, 2H), 1.20 (t, J = 7 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{38}H_{40}NO_7$ (p+1): m/z = 622.2805. Found: 622.2817. IR ($CHCl_3$, cm^{-1}) 2964, 1720, 1461.

Anal. Calcd for $C_{38}H_{39}NO_7$: C, 73.41; H, 6.32; N, 2.25. Found: C, 73.20; H, 6.34; N, 2.27.



B. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-isoxazol-5-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A solution of 2-{3-[3-(5-benzyloxy-2-ethyl-4-isoxazol-5-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (180 mg, 0.289 mmol) in ethanethiol (5 mL) was treated with boron trifluoride etherate (1.5 mL) at room temperature for 2 h, at which time an additional portion of boron trifluoride etherate (0.5 mL) was added and stirring resumed for an additional 1 h. The mixture was diluted with diethyl ether and water. The organic layer was separated, washed once with saturated sodium bicarbonate solution, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 15% ethyl acetate/85% hexane) of the residue provided 94 mg (61%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 8.28 (d, J = 1 Hz, 1H), 7.88 (dd, J = 8, 2 Hz, 1H), 7.38 (t, J = 8 Hz,1H), 7.36 (s, 1H), 7.08 (t, J = 8 Hz, 1H), 7.05 (d, J = 8 Hz, 1H), 6.81 (d, J = 8 Hz, 1H), 6.67 (d, J = 8 Hz, 1H), 6.50 (s, 1H), 6.45 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 4.20 (m, 4H), 3.83 (s, 3H), 2.62 (m, 4H), 2.34 (quintet, J = 6 Hz, 2H), 1.54 (hextet, J = 8 Hz, 2H), 1.18 (t, J = 8 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{31}H_{34}NO_7$ (p+1): m/z = 532.2335. Found: 532.2335. IR ($CHCl_3$, cm^{-1}) 2964, 1715, 1601, 1461. Anal. Calcd for $C_{31}H_{33}NO_7$: C, 70.04; H, 6.26; N, 2.63. Found: C, 70.13; H, 6.35; N, 2.63.



C. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-isoxazol-5-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid.

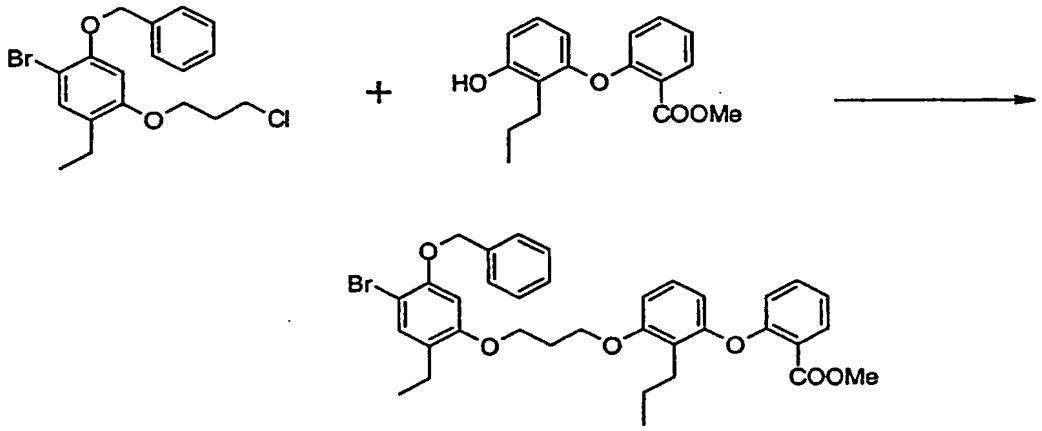
To a solution of 2-{3-[3-(2-ethyl-5-hydroxy-4-isoxazol-5-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (94 mg, 0.18 mmol) in methanol (3 mL) was added 1 M lithium hydroxide solution (1 mL) and the resulting mixture warmed at 60 °C for 3 h. The mixture was cooled to room temperature and concentrated in vacuo. The aqueous residue was diluted with water and the pH adjusted to ~4. The mixture was extracted three times with methylene chloride. The combined organic extracts were dried (sodium sulfate), filtered, and concentrated in vacuo to provide 12 mg (13%) of the title compound as an off-white amorphous solid. ^{1}H NMR ($CDCl_3$) δ 8.26 (s, 1H), 8.20 (dd, J = 8, 1 Hz, 1H), 7.49 (t, J = 6 Hz, 1H), 7.36 (s, 1H), 7.18 (d, J = 8 Hz, 1H), 7.15 (d, J = 8 Hz, 1H), 7.02 (bs, 1H), 6.80 (d, J = 8 Hz, 1H), 6.69 (d, J = 8 Hz, 1H), 6.60 (d, J = 8 Hz, 1H), 6.50 (s, 1H), 6.46 (s, 1H), 4.22 (t, J = 6 Hz, 2H), 4.19 (t, J = 6 Hz, 2H); 2.57 (m, 4H), 2.34 (quintet, J = 6 Hz, 2H), 1.47

(hextet, J = 8 Hz, 2H), 1.16 (t, J = 8 Hz, 3H), 0.85 (t, J = 7 Hz, 3H); TOS MS ES^+ exact mass calculated for $C_{30}H_{32}NO_7$ (p+1): m/z = 518.2179. Found: 518.2175.

Anal. Calcd for $C_{30}H_{31}NO_7$: C, 69.62; H, 6.04; N, 2.71. Found: C, 69.57; H, 6.15; N, 2.74.

Example 6

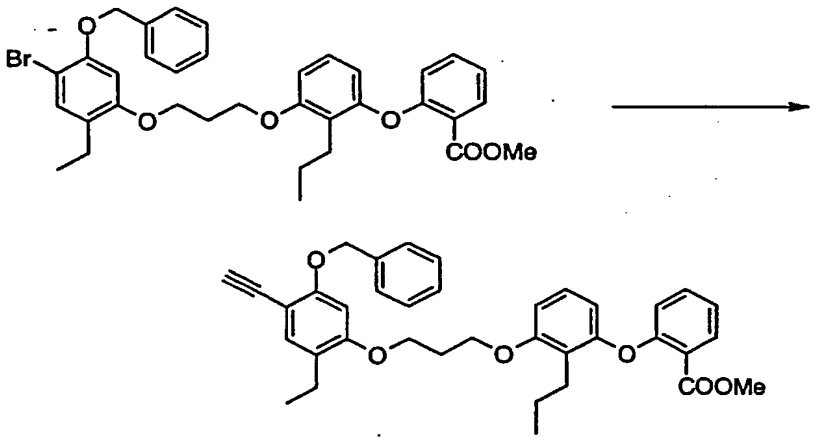
Preparation of 2-(3-{3-[2-Ethyl-5-hydroxy-4-(3*H*-[1,2,3]triazol-4-yl)phenoxy]propoxy}-2-propyl-phenoxy)benzoic acid.



A. Preparation of 2-{3-[3-(5-benzyloxy-4-bromo-2-ethylphenoxy)propoxy]-2-propylphenoxy}-benzoic acid methyl ester.

A mixture of 5-benzyloxy-4-bromo-1-(3-chloropropoxy)-2-ethylbenzene (1.19 g, 3.11 mmol), 2-(3-hydroxy-2-propylphenoxy)benzoic acid methyl ester (0.89 g, 3.1 mmol), potassium carbonate (1.29 g, 9.34 mmol), potassium iodide (0.52 g, 3.1 mmol), and methyl sulfoxide (2 mL) in 2-butanone (20 mL) was heated at reflux for 48 h. The mixture

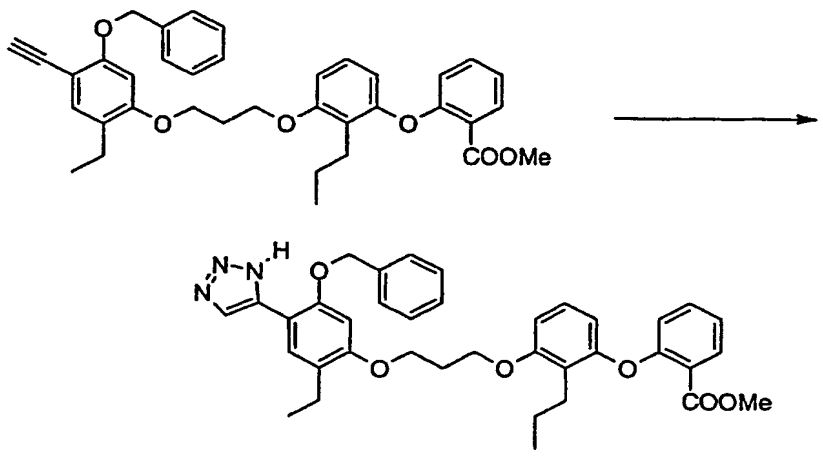
was cooled to room temperature, diluted with diethyl ether, and washed once with water. The organic layer was dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 6% ethyl acetate/94% hexane) of the residue provided 1.34 g (68%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.91 (dd, J = 8, 2 Hz, 1H), 7.50 (d, J = 7 Hz, 2H), 7.38 (m, 5H), 7.15 (d, J = 8 Hz, 1H), 7.10 (d, J = 8 Hz, 1H), 6.83 (d, J = 8 Hz, 1H), 6.71 (d, J = 8 Hz, 1H), 6.55 (s, 1H), 6.48 (, J = 8 Hz, 1H), 5.16 (s, 2H), 4.21 (t, J = 6 Hz, 2H), 4.15 (t, J = 6 Hz, 2H), 3.83 (s, 3H), 2.68 (t, J = 8 Hz, 2H), 2.58 (q, J = 7 Hz, 2H), 2.31 (quintet, J = 6 Hz, 2H), 1.58 (hextet, J = 6 Hz, 2H), 1.17 (t, J = 7 Hz, 3H), 0.93 (t, J = 7 Hz, 3H).



B. Preparation of 2-{3-[3-(5-benzyloxy-2-ethyl-4-ethynylphenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester.

A mixture of 2-{3-[3-(5-benzyloxy-4-bromo-2-ethylphenoxy)propoxy]-2-propylphenoxy}-benzoic acid methyl ester (1.50 g, 2.37 mmol), tri-n-butylethynyltin (0.82 mL,

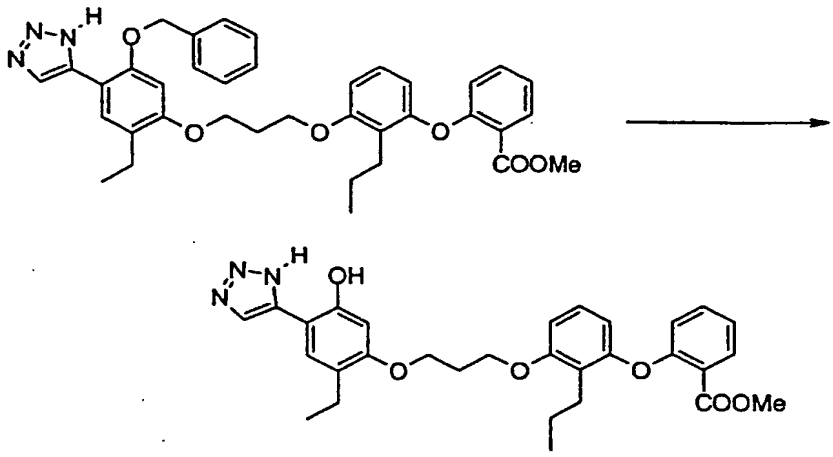
2.8 mmol), and tetrakis(triphenylphosphine)palladium (0) (1.0 g, 0.95 mmol) in N,N-dimethylformamide (25 mL) was purged with argon and heated in a sealed tube at 120 °C for 24 h. The mixture was cooled to room temperature and filtered. The filtrate was diluted with ethyl acetate, washed four times with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 532 mg (39%) of the title compound as a brown oil. ^{1}H NMR ($CDCl_3$) δ 7.88 (dd, J = 8, 2 Hz, 1H), 7.79 (s, 1H), 7.20-7.50 (m, 6H), 7.10 (d, J = 8 Hz, 1H), 7.05 (d, J = 8 Hz, 1H), 6.80 (d, J = 8 Hz, 1H), 6.66 (d, J = 8 Hz, 1H), 6.43 (m, 2H), 5.16 (s, 2H), 4.17 (t, J = 6 Hz, 2H), 4.11 (t, J = 6 Hz, 2H), 3.83 (s, 3H), 3.23 (s, 1H), 2.64 (t, J = 8 Hz, 2H), 2.53 (q, J = 7 Hz, 2H), 2.27 (quintet, J = 6 Hz, 2H), 1.53 (m, 2H), 1.13 (t, J = 7 Hz, 3H), 0.89 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{37}H_{39}O_6$ (p+1): m/z = 579.2747. Found: 579.2739.



C. Preparation of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(3H-[1,2,3]triazol-4-yl)phenoxy]-propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A mixture of 2-{3-[3-(5-benzyloxy-2-ethyl-4-ethynylphenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester (517 mg, 0.893 mmol) and trimethylsilyl azide (3.0 mL, 18 mmol) was heated in toluene (20 mL) in a sealed tube at 130 °C for 120 h. The mixture was cooled to room temperature and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane to 50% ethyl acetate/50% hexane) of the residue provided 347 mg (88% based upon recovered starting material) of the title compound as a brown solid. ^{1}H NMR ($CDCl_3$) δ 8.10 (bs, 1H), 7.89 (dd, J = 8, 2 Hz, 1H), 7.76 (s, 1H), 7.40 (m, 7H), 7.10 (d, J = 8 Hz, 1H), 7.05 (d, J = 8 Hz, 1H), 6.79 (d, J = 8 Hz, 1H), 6.67 (d, J = 8 Hz, 1H), 6.62 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 5.18 (s, 2H), 4.21 (m, 4H), 3.82 (s, 3H), 2.65 (m, 4H), 2.32 (quintet, J = 6 Hz, 2H), 1.56 (hextet, J = 8 Hz, 2H), 1.21 (t, J = 8 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{37}H_{40}N_3O_6$ (p+1): m/z = 622.2917. Found: 622.2946. IR ($CHCl_3$, cm^{-1}) 3400, 1721, 1602, 1453.

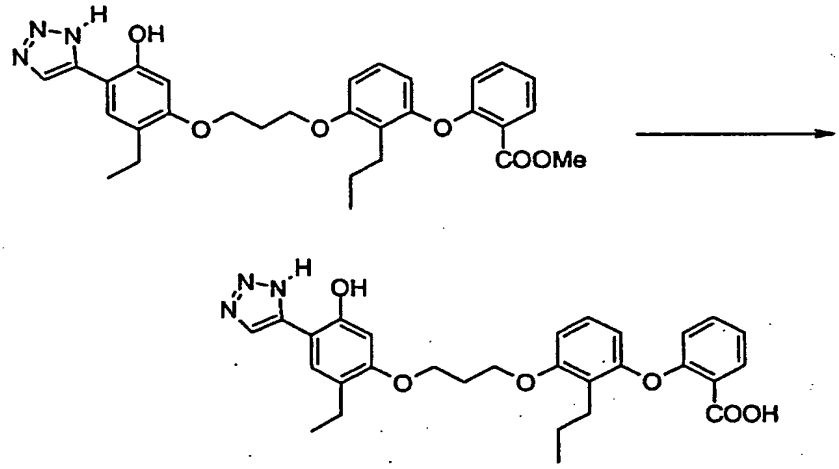
Anal. Calcd for $C_{37}H_{39}N_3O_6$: C, 71.48; H, 6.32; N, 6.76. Found: C, 70.28; H, 6.07; N, 6.54.



D. Preparation of 2-(3-{3-[2-ethyl-5-hydroxy-4-(3*H*-[1,2,3]triazol-4-yl)phenoxy]-propoxy}-2-propyl-phenoxy)benzoic acid methyl ester.

A solution of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(3*H*-[1,2,3]triazol-4-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (330 mg, 0.531 mmol) in ethanethiol (9 mL) was treated with boron trifluoride etherate (2.0 mL,16 mmol) for 1 h at room temperature and then with an additional portion of boron trifluoride etherate (1.0 mL) for 1 h. The mixture was diluted with diethyl ether and water. The organic layer was washed once with saturated sodium bicarbonate solution, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 30% ethyl acetate/70% hexane to 50% ethyl acetate/50% hexane) of the residue provided 180 mg (63%) of the title compound as a brown solid. ^{1}H NMR ($CDCl_3$) δ 7.97 (s, 1H), 7.88 (dd, J = 8, 2 Hz, 1H), 7.37 (t, J = 8 Hz, 1H), 7.31 (s, 1H), 7.10 (d, J = 8 Hz, 1H), 7.05 (d, J = 8 Hz, 1H), 6.81 (d, J = 8 Hz, 1H), 6.67 (d, J = 8 Hz, 1H), 6.59 (s, 1H), 6.43 (d, J = 8 Hz,

1H), 4.20 (m, 4H), 3.83 (s, 3H), 2.63 (m, 4H), 2.34 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 8 Hz, 2H), 1.19 (t, J = 8 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{30}H_{34}N_3O_6$ (p+1): m/z = 532.2447. Found: 532.2466. IR ($CHCl_3$, cm^{-1}) 2964, 1718, 1453. Anal. Calcd for $C_{30}H_{33}N_3O_6$: C, 67.78; H, 6.26; N, 7.90. Found: C, 66.80; H, 6.02; N, 7.53.



E. Preparation of 2-(3-{3-[2-ethyl-5-hydroxy-4-(3*H*-[1,2,3]triazol-4-yl)phenoxy]-propoxy}-2-propylphenoxy)benzoic acid.

A solution of 2-(3-{3-[2-ethyl-5-hydroxy-4-(3*H*-[1,2,3]triazol-4-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (160 mg, 0.30 mmol) in methanol (5 mL) was treated 1 N lithium hydroxide solution (1.5 mL) at 60 °C for 3.5 h. The mixture was cooled to room temperature, diluted with water, and adjusted to ~pH 4. The resulting mixture was extracted three times with methylene chloride. The

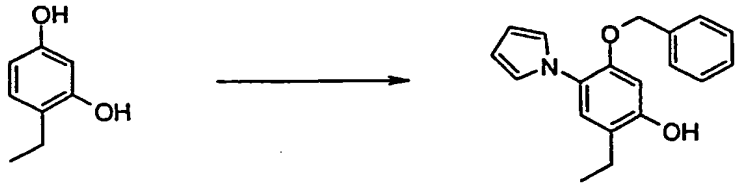
combined organic extracts were dried (sodium sulfate), filtered, and concentrated in vacuo to provide 134 mg (86%) of the title compound as a tan solid. ^{1}H NMR (DMSO-d) δ 14.98 (bs, 1H), 12.80 (bs, 1H), 10.02 (bs, 1H), 8.17 (bs, 1H), 7.77 (dd, J = 7, 2 Hz, 1H), 7.60 (bs, 1H), 7.47 (t, J = 8 Hz, 1H), 7.18 (t, J = 8 Hz, 1H), 7.14 (t, J = 8 Hz, 1H), 6.82 (d, J = 8 Hz, 1H), 6.68 (d, J = 8 Hz, 1H), 6.57 (s, 1H), 6.35 (d, J = 8 Hz, 1H), 4.22 (t, J = 6 Hz, 2H), 4.15 (t, J = 6 Hz, 2H), 2.54 (m, 4H), 2.25 (quintet, J = 6 Hz, 2H), 1.45 (hextet, J = 8 Hz, 2H), 1.11 (t, J = 7 Hz, 3H), 0.81 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{29}H_{32}N_3O_6$ (p+1): m/z = 518.2291. Found: 518.2302.

IR ($CHCl_3$, cm^{-1}) 2965, 1738, 1454.

Anal. Calcd for $C_{29}H_{31}N_3O_6$: C, 67.30; H, 6.04; N, 8.12. Found: C, 67.15; H, 5.98; N, 7.93.

Example 7

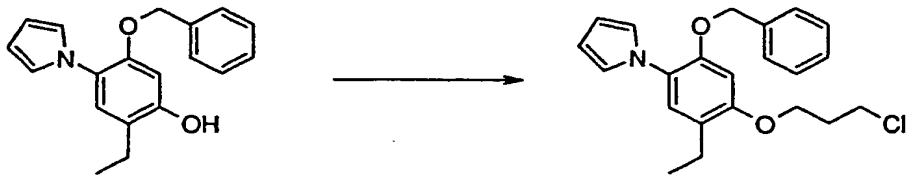
Preparation of 2-{3-[3-(2-Ethyl-5-hydroxy-4-pyrrol-1-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester.



A. Preparation of 5-benzyloxy-2-ethyl-4-pyrrol-1-yl-phenol. To a mixture of potassium nitrosodisulfonate (40.0 g, 149 mmol) and potassium hydrogen phosphate (10 g) in water (1.2 L) at room temperature was added a solution of 4-

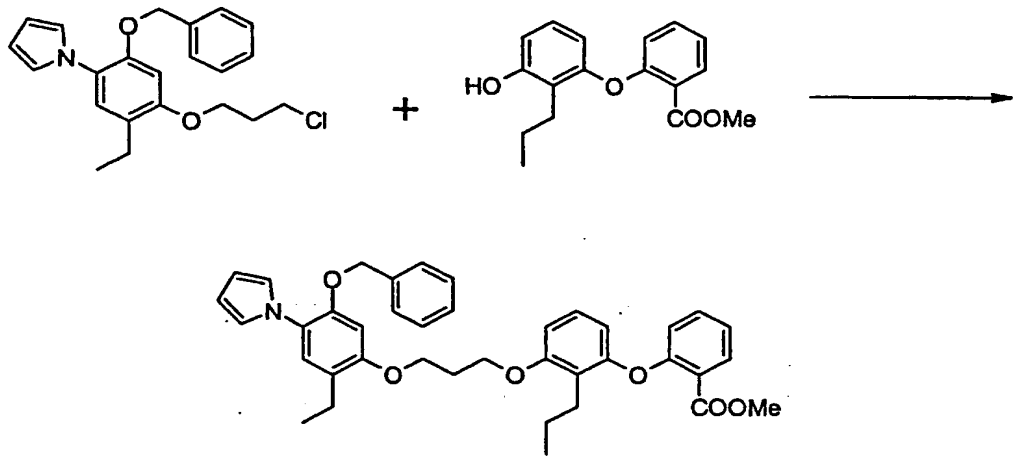
ethylbenzene-1,3-diol (10.0 g, 2.37 mmol) and potassium hydrogen phosphate (10.5 g) in water (150 mL). The mixture was stirred for 15 min and adjusted to pH ~3. The solution was extracted three times with diethyl ether. The organic layer was dried (sodium sulfate), filtered, and concentrated in vacuo. The residue was dissolved in acetonitrile (70 mL) and treated at room temperature with 65% 3-pyrroline (12 mL). The resulting mixture was stirred for 1 h and concentrated in vacuo, dissolved in ethyl acetate and hexane, and filtered down a short column of silica gel. The resulting solution was concentrated in vacuo. The residue was dissolved in N,N-dimethylformamide (10 mL) and treated with benzyl bromide (0.85 mL, 7.1 mmol) and potassium carbonate (960 mg, 6.9 mmol) at room temperature for 15 h. The mixture was diluted with ethyl acetate, washed four times with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, ethyl acetate/hexane gradient) of the residue provided 316 mg (2%) of the title compound. TOF MS ES^+ exact mass calculated for $C_{19}H_{20}NO_2$ (p+1): m/z = 294.1494. Found: 294.1471.

B. Preparation of 1-[2-benzyloxy-4-(3-chloropropoxy)-5-ethylphenyl]-1*H*-pyrrole.



A mixture of 5-benzyloxy-2-ethyl-4-pyrrol-1-yl-phenol (316 mg, 1.08 mmol), potassium carbonate (223 mg, 1.62 mmol), and 1-bromo-3-chloropropane (0.16 mL, 1.6 mmol) in N,N-

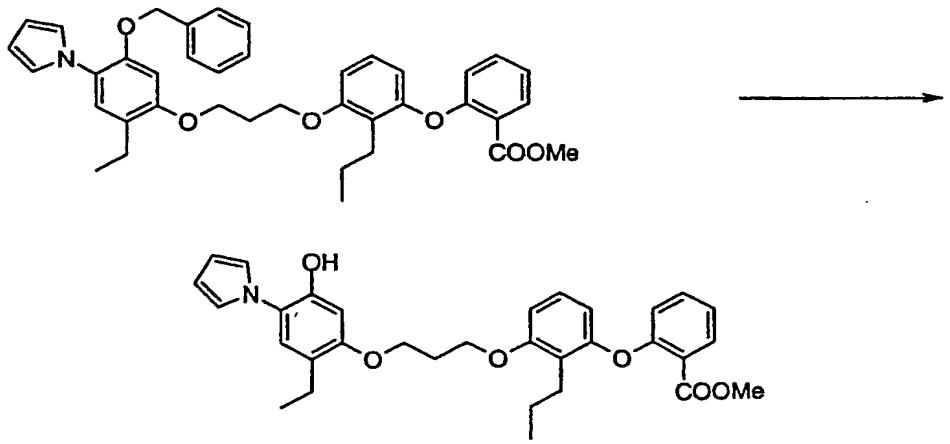
dimethylformamide (5 mL) was stirred at room temperature for 18 h. The mixture was diluted with ethyl acetate and water, washed four times with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 5% ethyl acetate/95% hexane) of the residue provided 314 mg (79%) of the title compound as a colorless oil. TOF MS ES^+ exact mass calculated for $C_{22}H_{25}NClO_2$ (p+1): m/z = 370.1574. Found: 370.1548.



C. Preparation of 2-{3-[3-(5-benzyloxy-2-ethyl-4-pyrrol-1-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A mixture of 1-[2-benzyloxy-4-(3-chloropropoxy)-5-ethylphenyl]-1*H*-pyrrole (310 mg, 0.85 mmol) and sodium iodide (140 mg, 0.94 mol) in 2-butanone (5 mL) was heated at reflux for 6 h. The mixture was cooled to room temperature, filtered, and concentrated in vacuo. The residue was dissolved in N,N-dimethylformamide (7 mL) and treated with

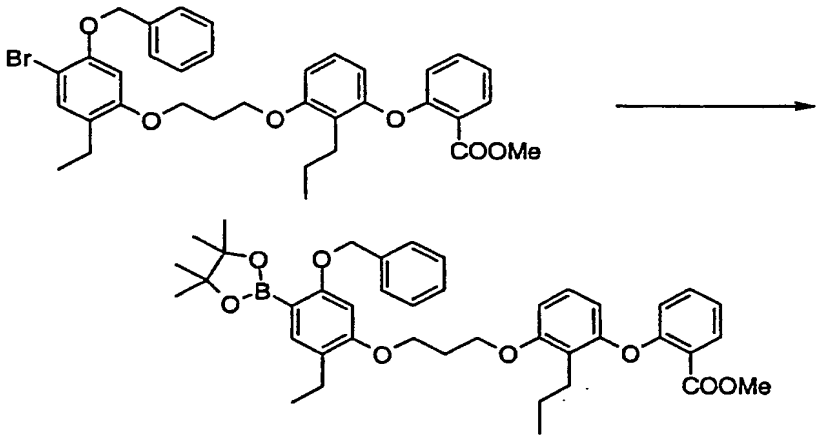
2-(3-hydroxy-2-propylphenoxy)benzoic acid methyl ester (242 mg, 0.85 mmol) and potassium carbonate (129 g, 93 mmol) at room temperature for 15 h. The mixture was diluted with ethyl acetate and water, washed four times with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 5% ethyl acetate/95% hexane) of the residue provided 196 mg (37%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.86 (dd, J = 8, 2 Hz, 1H), 7.37 (dt, J = 8, 2 Hz, 1H), 7.30 (m, 5H), 7.07 (m, 3H), 6.84 (m, 2H), 6.79 (d, J = 8 Hz, 1H), 6.65 (d, J = 8 Hz, 1H), 6.58 (s, 1H), 6.42 (d, J = 8 Hz, 1H), 6.29 (m, 2H), 4.92 (s, 2H), 4.17 (t, J = 6 Hz, 2H), 4.15 (t, J = 6 Hz, 2H), 3.83 (s, 3H), 2.65 (t, J = 8 Hz, 2H), 2.58 (q, J = 7 Hz, 2H), 2.30 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 8 Hz, 2H), 1.16 (t, J = 7 Hz, 3H), 0.80 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{39}H_{42}NO_6$ (p+1): m/z = 620.3012. Found: 620.3021.



D. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-pyrrol-1-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester. A solution of 2-{3-[3-(5-benzyloxy-2-ethyl-4-pyrrol-1-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (195 mg, 0.315 mmol) in ethanethiol (5 mL) was treated with boron trifluoride etherate (1.3 mL, 9.5 mmol) at room temperature for 2.5 h. The mixture was diluted with diethyl ether and water. The organic layer was washed with saturated sodium bicarbonate solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 39 mg (23%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.89 (d, J = 8 Hz, 1H), 7.37 (t, J = 8 Hz, 1H), 7.07 (m, 2H), 6.98 (s, 1H), 6.68 (m, 3H), 6.65 (d, J = 8 Hz, 1H), 6.57 (s, 1H), 6.42 (d, J = 8 Hz, 1H), 6.35 (m, 2H), 5.04 (bs, 1H), 4.19 (m, 2H), 3.83 (s, 3H), 2.64 (t, J = 8 Hz, 2H), 2.58 (q, J = 7 Hz, 2H), 2.32 (quintet, J = 6 Hz, 2H), 1.55 (m, 2H), 1.14 (t, J = 7 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{32}H_{36}NO_6$ (p+1): m/z = 530.2543. Found: 530.2516.

Example 8

Preparation of 2-(3-{3-[4-(3-Bromo-[1,2,4]thiadiazol-5-yl)-2-ethyl-5-hydroxyphenoxy]-propoxy}-2-propylphenoxy)benzoic acid.

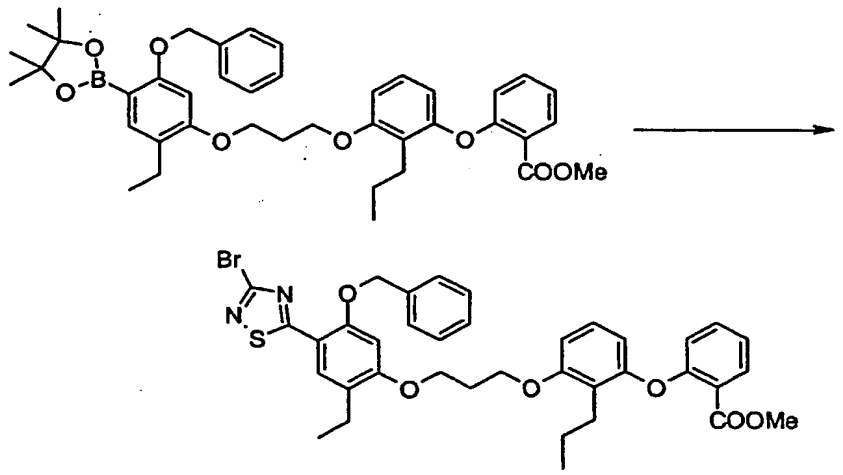


A. Preparation of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A mixture of 2-{3-[3-(5-benzyloxy-4-bromo-2-ethylphenoxy)propoxy]-2-propylphenoxy}-benzoic acid methyl ester (8.30 g, 13.1 mmol), triethylamine (5.2 mL, 39 mmol), and $PdCl_2$(dppf) (320 mg, 0.39 mmol) in de-oxygenated toluene (80 mL) was treated with a 1 M solution of 4,4,5,5-tetramethyl-[1,3,2]dioxaborolane in tetrahydrofuran (20 mL, 20 mmol) and heated at reflux for 6 h. The mixture was filtered down a short column of silica gel and the filtrate concentrated in vacuo. Chromatography (silica gel, 35% ethyl acetate/65% hexane) of the residue provided a dark oil that was subjected to further chromatography (silica gel, hexane to 30% ethyl acetate/70% hexane) to give 7.70 g (84%)

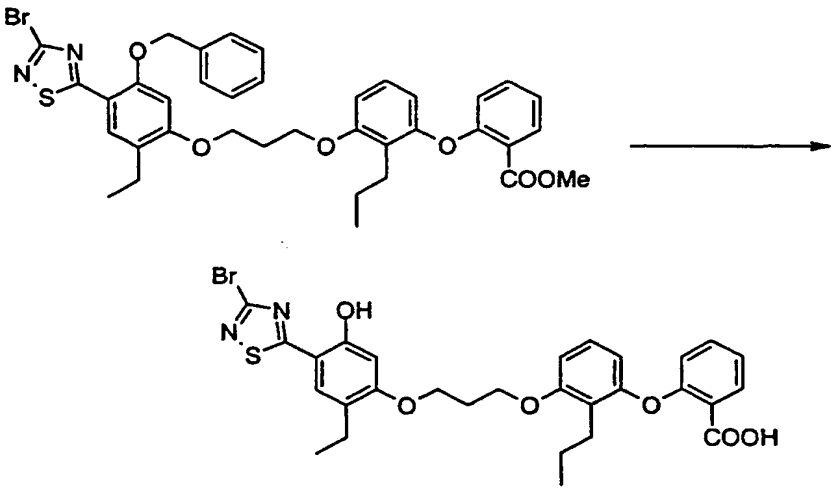
of the title compound. ^{1}H NMR ($CDCl_3$) δ 7.86 (dd, J = 8, 2 Hz, 1H), 7.60 (d, J = 8 Hz, 2H), 7.47 (s, 1H), 7.34 (m, 3H), 7.24 (t, J = 8 Hz, 1H), 7.09 (d, J = 9 Hz, 1H), 7.04 (d, J = 9 Hz, 1H), 6.79 (d, J = 9 Hz, 1H), 6.66 (d, J = 9 Hz, 1H), 6.47 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 5.07 (s, 2H), 4.18 (m, 4H), 3.81 (s, 3H), 2.64 (t, J = 8 Hz, 2H), 2.56 (q, J = 7 Hz, 2H), 2.30 (quintet, J = 6 Hz, 2H), 1.53 (hextet, J = 8 Hz, 2H), 1.34 (s, 12H),1.14 (t, J = 7 Hz, 3H), 0.89 (t, J = 7 Hz, 3H); TOF MS ES^+ exact mass calculated for $C_{41}H_{53}NBO_8$ (p + NH_4): m/z = 698.3864. Found: 698.3889. IR ($CHCl_3$, cm^{-1}) 2964, 1720, 1604, 1453.

Anal. Calcd for $C_{41}H_{49}BO_8$: C, 72.35; H, 7.26. Found: C, 72.30; H, 7.12.



B. Preparation of 2-(3-{3-[5-benzyloxy-4-(3-bromo-[1,2,4]thiadiazol-5-yl)-2-ethyl-phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A mixture of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (310 mg, 0.46 mmol), 3-bromo-5-chloro-1,2,4-thiadiazole (120 mg, 0.60 mmol), cesium carbonate (300 mg, 0.92 mmol), and $PdCl_2$(dppf) (20 mg, 0.024 mmol) in de-oxygenated toluene (10 mL) was heated at 100 °C for 15 h. The mixture was diluted with a solution of 35% ethyl acetate/65% hexane and filtered down a short column of silica gel. The filtrate was concentrated in vacuo. Chromatography (silica gel, hexane to 30% ethyl acetate/70% hexane) of the residue provided 232 mg (70%) of the title compound. ^{1}H NMR ($CDCl_3$) δ 8.13 (s, 1H), 7.87 (dd, J = 8, 2 Hz, 1H), 7.44 (m, 2H), 7.37 (m, 4H), 7.08 (t, dJ = 8, 1 Hz, 1H), 7.04 (d, J = 9 Hz, 1H), 6.78 (d, J = 9 Hz, 1H), 6.66 (d, J = 9 Hz, 1H), 6.55 (s, 1H), 6.43 (d, J = 8 Hz, 1H), 5.28 (s, 2H), 4.21 (t, J = 6 Hz, 2H), 4.19 (t, J = 6 Hz, 2H), 3.81 (s, 3H), 2.62 (m, 4H), 2.34 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 8 Hz, 2H), 1.17 (t, J = 7 Hz, 3H), 0.88 (t, J = 7 Hz, 3H); MS ES^+ m/e 717, 719.



C. Preparation of 2-(3-{3-[4-(3-bromo-[1,2,4]thiadiazol-5-yl)-2-ethyl-5-hydroxyphenoxy]propoxy}-2-propylphenoxy)benzoic acid.

A solution of 2-(3-{3-[5-benzyloxy-4-(3-bromo-[1,2,4]thiadiazol-5-yl)-2-ethyl-phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (230 mg, 0.31 mmol) in ethanethiol (4 mL) was treated with boron trifluoride etherate (0.32 mL, 2.5 mmol) at room temperature for 6 h, at which time an additional portion of boron trifluoride etherate was added and stirring continued for 7 h. The reaction mixture was diluted with water, concentrated in vacuo, and extracted with diethyl ether. The residue was dissolved in methanol (5 mL) and treated with 1 N lithium hydroxide solution (2 mL) at 65 °C for 1 h. The mixture was concentrated in vacuo and the residue diluted with water and adjusted to ~pH 3 with 1 N hydrochloric acid. The resulting precipitate was collected via vacuum filtration and dissolved in dilute aqueous base. Reverse phase chromatography (1:1 acetonitrile/water) provided 43 mg (23%)

of the title compound as a yellow solid. ^{1}H NMR (DMSO-d_6) δ 7.85 (s, 1H), 7.80 (dd, J = 8, 2 Hz, 1H), 7.45 (m, 2H), 7.15 (m, 3H), 6.83 (d, J = 9 Hz, 1H), 6.80 (d, J = 9 Hz, 1H), 6.62 (s, 1H), 6.35 (d, J = 9 Hz, 1H), 4.20 (m, 4H), 2.55 (m, 4H), 2.27 (quintet, J = 5 Hz, 2H), 1.44 (hextet, J = 8 Hz, 2H), 1.13 (t, J = 7 Hz, 3H), 0.81 (t, J = 7 Hz, 3H); MS ES$^+$ m/e 551 (p+NH_4^+-Br); IR (KBr, cm^{-1}) 2900, 1696, 1603, 1461. Anal. Calcd for $C_{29}H_{29}BrN_2O_6S$: C, 56.77; H, 4.76; N, 4.56. Found: C, 56.63; H, 4.72; N, 3.98.

Example 9

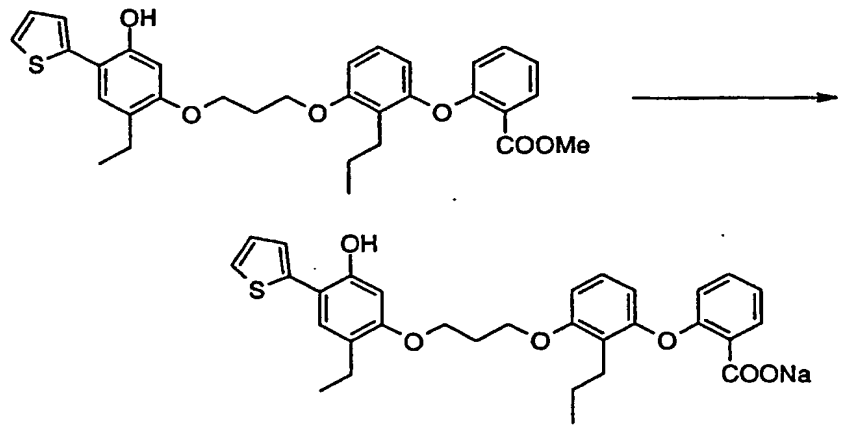
Preparation of 2-{3-[3-(2-Ethyl-5-hydroxy-4-thiophen-2-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid sodium salt.

A. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-thiophen-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A mixture of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (300 mg, 0.44 mmol), 2-bromothiophene (110 mg, 0.66 mmol), cesium carbonate (300 mg, 2.17 mmol), and $PdCl_2$(dppf) (20 mg, 0.024 mmol) in de-oxygenated toluene (10 mL) was heated at 105 °C for 66 h. The mixture was cooled to room temperature and concentrated in vacuo. The residue was dissolved in methylene chloride and filtered down a short column of silica gel. The filtrate was concentrated in vacuo. Chromatography (silica gel, 30% ethyl acetate/70% hexane) of the residue provided an oil that was dissolved in ethanethiol (4 mL) and treated

with boron trifluoride etherate (0.44 mL, 3.4 mmol) at room temperature for 3 h. The mixture was diluted with water and extracted with diethyl ether. The organic layer was dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, hexane to 30% ethyl acetate/70% hexane) of the residue provided 120 mg (50%) of the title compound as a yellow film. ^{1}H NMR ($CDCl_3$) δ 7.85 (dd, J = 8, 2 Hz, 1H), 7.35 (t, J = 8 Hz, 1H), 7.15 (d, J = 7 Hz, 1H), 7.03-7.15 (m, 5H), 6.80 (d, J = 9 Hz, 1H), 6.66 (d, J = 9 Hz, 1H), 6.51 (s, 1H), 6.42 (d, J = 8 Hz, 1H), 5.44 (bs, 1H), 4.18 (m, 4H), 3.82 (s, 3H), 2.62 (t, J = 8 Hz, 2H), 2.58 (q, J = 7 Hz, 2H), 2.54 (quintet, J = 6 Hz, 2H), 1.52 (hextet, J = 8 Hz, 2H), 1.16 (t, J = 7 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); MS ES$^-$ m/e 545 (p - 1).

B. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-thiophen-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid sodium salt.

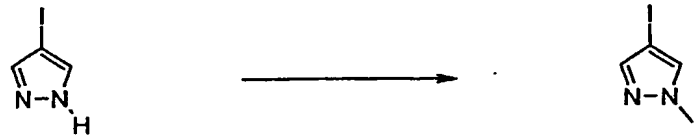


A solution of 2-{3-[3-(2-ethyl-5-hydroxy-4-thiophen-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (120 mg, 0.22 mmol) in methanol (3 mL) was treated with 1 N

lithium hydroxide solution (0.5 mL) at room temperature for 1 h and then with an additional portion of 1 N lithium hydroxide solution (0.75 mL) for 18 h. The mixture was heated at 50 °C then concentrated in vacuo. The residue was acidified with dilute hydrochloric acid and extracted with diethyl ether. The organic layer was washed once with water and concentrated in vacuo. The residue was diluted with 1 N sodium hydroxide solution (0.22 mL), diethyl ether, and toluene. The mixture was concentrated in vacuo, dissolved in methylene chloride, and concentrated in vacuo to provide 120 mg (98%) of the title compound as a green film. ^{1}H NMR (DMSO-d_6) δ 7.71 (d, J = 8 Hz, 1H), 7.42 (m, 2H), 7.31 (m, 2H), 7.10 (m, 2H), 6.99 (m, 1H), 6.76 (t, J = 7 Hz, 2H), 6.52 (s, 1H), 6.30 (d, J = 8 Hz, 1H), 4.16 (t, J = 7 Hz, 2H), 4.07 (t, J = 7 Hz, 2H), 2.50 (m, 4H), 2.20 (m, 2H), 1.40 (m, 2H), 1.06 (t, J = 8 Hz, 3H), 0.77 (t, J = 7 Hz, 3H); MS ES$^+$ m/e 533 (p + 1 − Na$^+$). IR ($CHCl_3$, cm^{-1}) 2900, 1738, 1604, 1454.

Example 10

Preparation of 2-(3-{3-[2-Ethyl-5-hydroxy-4-(1-methyl-1H-pyrazol-4-yl)-phenoxy]propoxy}-2-propylphenoxy)benzoic acid.



A. Preparation of 4-iodo-1-methylpyrazole (Known compound: RN 39806-90-1).

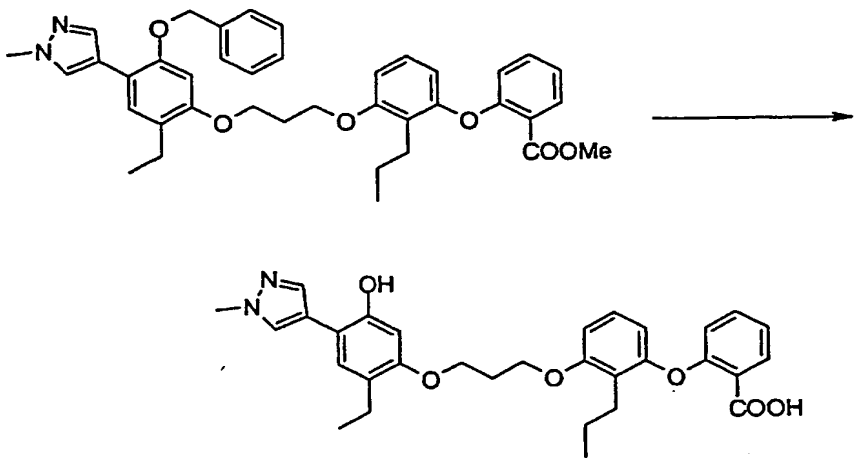
To a solution of 4-iodopyrazole (1.3 g, 6.8 mmol) in dioxane (10 mL) was added iodomethane (0.42 mL, 6.8 mmol) and the

resulting mixture stirred at room temperature for 96 h. The mixture was concentrated in vacuo and the residue mixed with methylene chloride and filtered. The filtrate was concentrated in vacuo to provide 1.35 g (95%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.47 (s, 1H), 7.38 (s, 1H), 3.90 (s, 3H).

B. Preparation of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(1-methyl-1*H*-pyrazol-4-yl)phenoxy]-propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A mixture of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (1.00 g, 1.47 mmol), 4-iodo-1-methylpyrazole (450 mg, 2.16 mmol), cesium carbonate (1.20 g, 3.62 mmol), and $PdCl_2$(dppf) (72 mg, 0.088 mmol) in de-oxygenated toluene (35 mL) was heated at 100 °C for 24 h. Additional portions of 4-iodo-1-methylpyrazole (~30 mg) and $PdCl_2$(dppf) (~30 mg) were added and heating continued at 100 °C for 40 h. The mixture was cooled to room temperature, concentrated in vacuo, diluted with methylene chloride, and filtered down a short plug of silica gel. The filtrate was concentrated in vacuo. Chromatography (silica gel, 35% ethyl acetate/65% hexane to 65% ethyl acetate/35% hexane) of the residue provided 710 mg (76%) of the title compound. ^{1}H NMR ($CDCl_3$) δ 7.86 (dd, J = 8, 2 Hz, 1H), 7.80 (s, 1H), 7.69 (s, 1H), 7.37 (m, 6H), 7.28 (s, 1H), 7.09 (d, J = 9 Hz, 1H), 7.04 (d, J = 9 Hz, 1H), 6.78 (d, J = 9 Hz, 1H), 6.67 (d, J = 9 Hz, 1H), 6.56 (s, 1H), 6.42 (d, J = 8 Hz, 1H), 5.08 (s, 2H), 4.18 (t, J = 6 Hz, 2H), 4.15 (t, J = 6 Hz, 2H), 3.85 (s, 3H), 3.81 (s, 3H),

2.63 (t, J = 8 Hz, 2H), 2.59 (q, J = 7 Hz, 2H), 2.30 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 8 Hz, 2H), 1.23 (t, J = 7 Hz, 3H), 0.89 (t, J = 7 Hz, 3H).



C. Preparation of 2-(3-{3-[2-ethyl-5-hydroxy-4-(1-methyl-1*H*-pyrazol-4-yl)-phenoxy]propoxy}-2-propylphenoxy)benzoic acid.

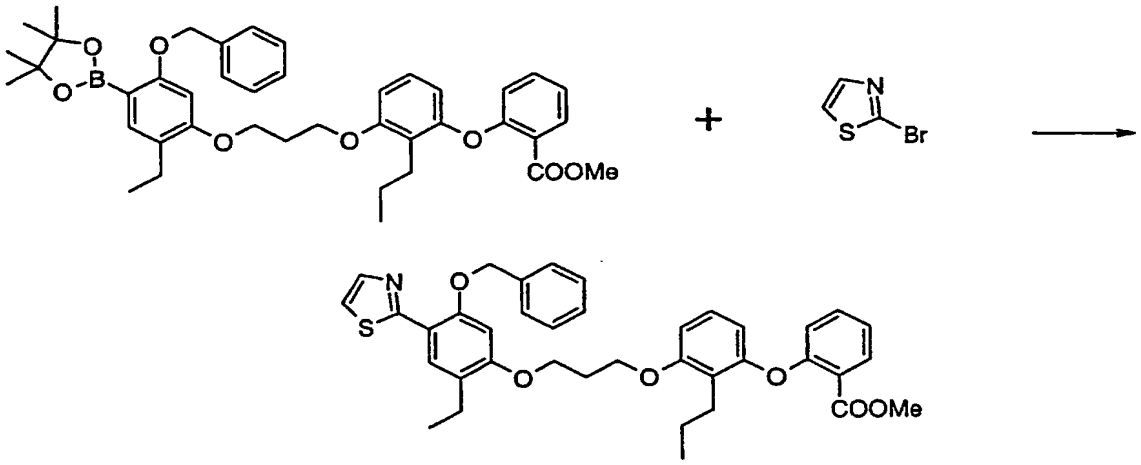
A solution of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(1-methyl-1*H*-pyrazol-4-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (710 mg, 1.12 mmol) in ethanethiol (5 mL) was treated with boron trifluoride etherate (1.42 mL, 11.2 mmol) at room temperature for 20 h. The reaction mixture was diluted with water, concentrated in vacuo, and extracted with diethyl ether. The organic layer was dried (magnesium sulfate), filtered, and concentrated in vacuo. The residue was triturated twice with hexane and the residue dissolved in methanol (5 mL). This solution was treated with 1 N lithium hydroxide solution (5 mL) at ~95 °C for 2 h. The mixture was concentrated in vacuo and the residue diluted with water, washed twice with diethyl ether, and the aqueous

layer acidified with 1 N hydrochloric acid. The resulting solution was extracted with diethyl ether. The organic layer was dried (magnesium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% methanol/90% methylene chloride) provided 338 mg (57%) of the title compound as a tan foam. ^{1}H NMR (DMSO-d_6) δ 12.85 (bs, 1H), 9.50 (bs, 1H), 7.98 (s, 1H), 7.78 (m, 2H), 7.48 (dt, J = 8, 2 Hz, 1H), 7.44 (s, 1H), 7.18 (t, J = 8 Hz, 1H), 7.13 (t, J = 9 Hz, 1H), 6.79 (d, J = 9 Hz, 1H), 6.77 (d, J = 9 Hz, 1H), 6.53 (s, 1H), 6.35 (d, J = 9 Hz, 1H), 4.20 (t, J = 6 Hz, 2H), 4.08 (t, J = 6 Hz, 2H), 3.85 (s, 3H), 2.50 (m, 4H), 2.24 (quintet, J = 5 Hz, 2H), 1.45 (hextet, J = 8 Hz, 2H), 1.09 (t, J = 7 Hz, 3H), 0.82 (t, J = 7 Hz, 3H); MS ES$^+$ m/e 531 (p+1); IR (KBr, cm^{-1}) 2961, 1697, 1602, 1460, 1222.

Anal. Calcd for $C_{31}H_{34}N_2O_6$: C, 70.17; H, 6.46; N, 5.28. Found: C, 69.27; H, 6.08; N, 4.63.

Example 11

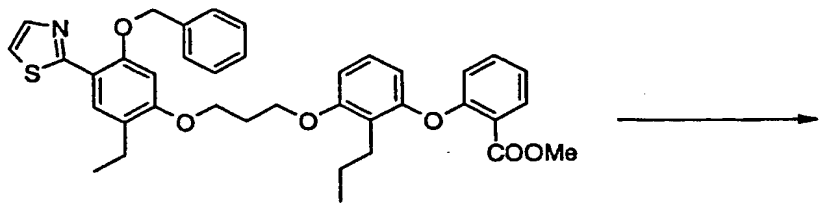
Preparation of 2-{3-[3-(2-Ethyl-5-hydroxy-4-thiazol-2-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid.

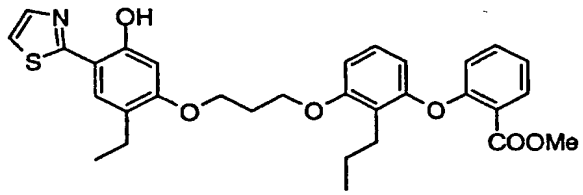


A. Preparation of 2-{3-[3-(5-benzyloxy-2-ethyl-4-thiazol-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A mixture of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (960 mg, 1.41 mmol), 2-bromothiazole (0.25 mL, 2.8 mmol), cesium carbonate (1.15 g, 3.52 mmol), and $PdCl_2$(dppf) (35 mg, 0.040 mmol) in deoxygenated toluene (35 mL) was heated at 60 °C for 16 h then at 100 °C for 7 h. Additional portions of 2-bromothiazole (0.13 mL) and $PdCl_2$(dppf) (~30 mg) were added and heating continued at 100 °C for 72 h. The mixture was cooled to room temperature, concentrated in vacuo, diluted with methylene chloride, and filtered down a short plug of silica gel. The filtrate was concentrated in vacuo.

Chromatography (silica gel, hexane to 35% ethyl acetate/65% hexane) of the residue provided 282 mg (31%) of the title compound. ^{1}H NMR ($CDCl_3$) δ 8.20 (s, 1H), 7.86 (dd, J = 8, 1 Hz, 1H), 7.82 (d, J = 3 Hz, 1H), 7.49 (d, J = 7 Hz, 2H), 7.35 (m, 4H), 7.23 (d, J = 3 Hz, 1H), 7.09 (d, J = 9 Hz, 1H), 7.04 (d, J = 9 Hz, 1H), 6.78 (d, J = 9 Hz, 1H), 6.65 (d, J = 9 Hz, 1H), 6.57 (s, 1H), 6.42 (d, J = 8 Hz, 1H), 5.24 (s, 2H), 4.17 (m, 4H), 3.81 (s, 3H), 2.63 (m, 4H), 2.33 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 8 Hz, 2H), 1.19 (t, J = 7 Hz, 3H), 0.88 (t, J = 7 Hz, 3H).

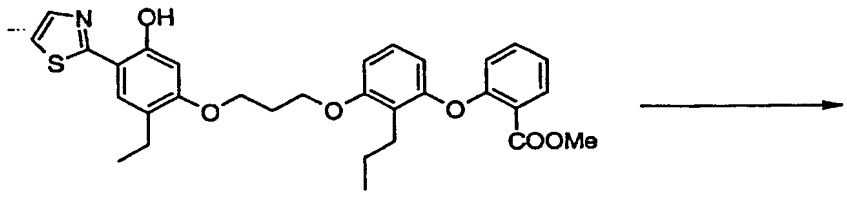


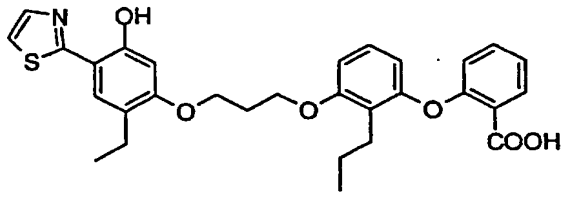


B. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-thiazol-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A solution of 2-{3-[3-(5-benzyloxy-2-ethyl-4-thiazol-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (282 mg, 0.442 mmol) in ethanethiol (3 mL) was treated with boron trifluoride etherate (0.56 mL, 4.4 mmol) at room temperature for 3 h. The reaction mixture was diluted with

water, concentrated in vacuo, and extracted with diethyl ether. The organic layer was dried (magnesium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, ethyl acetate/hexane) provided 107 mg (44%) of the title compound. ^{1}H NMR ($CDCl_3$) δ 7.88 (dd, J = 8, 2 Hz, 1H), 7.80 (d, J = 4 Hz, 1H), 7.35 (dt, J = 8, 2 Hz, 1H), 7.28 (d, J = 4 Hz, 1H), 7.24 (s, 1H), 7.09 (dt, J = 9, 2 Hz, 1H), 7.05 (t, J = 9 Hz, 1H), 6.79 (d, J = 9 Hz, 1H), 6.66 (d, J = 9 Hz, 1H), 6.61 (s, 1H), 6.42 (d, J = 9 Hz, 1H), 4.24 (t, J = 6 Hz, 2H), 4.18 (t, J = 6 Hz, 2H), 3.81 (s, 3H), 2.63 (t, J = 7 Hz, 2H), 2.58 (q, J = 7 Hz, 2H), 2.34 (quintet, J = 6 Hz, 2H), 1.52 (hextet, J = 8 Hz, 2H), 1.17 (t, J = 7 Hz, 3H), 0.88 (t, J = 7 Hz, 3H); MS ES$^+$ m/e 548 (p+1).





C. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-thiazol-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid.

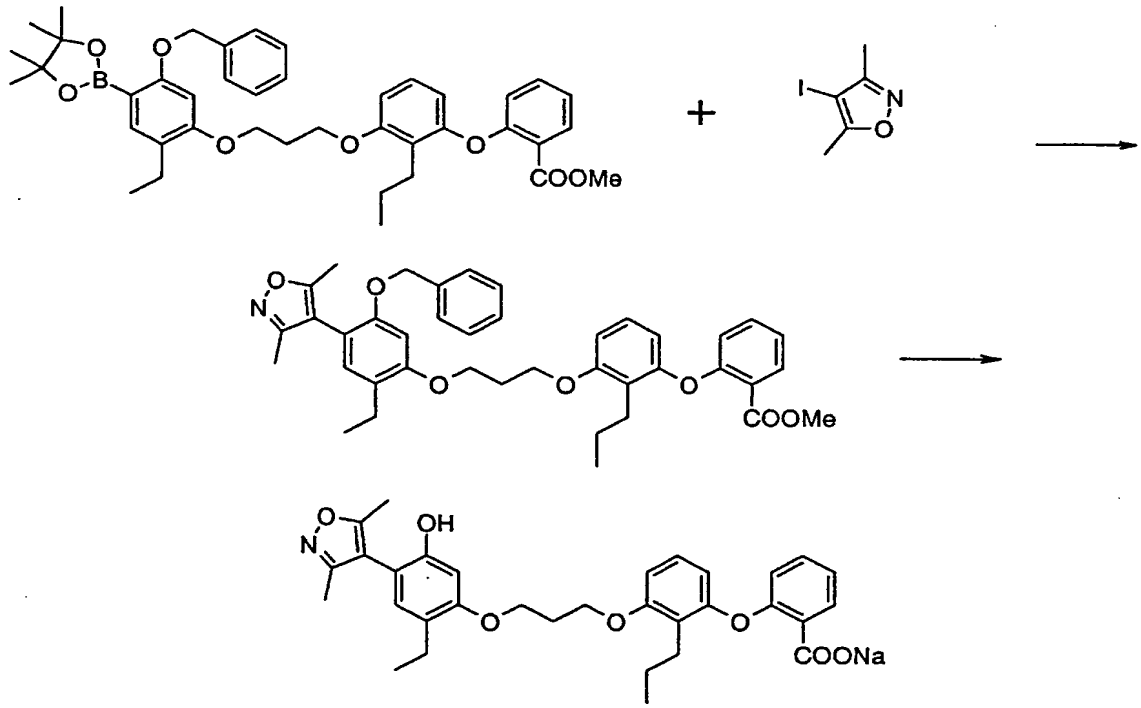
2-{3-[3-(2-Ethyl-5-hydroxy-4-thiazol-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (107 mg, 0.196

mmol) was dissolved in a 1:1 solution of methanol/dioxane (3 mL) and treated with 1 N lithium hydroxide solution (1 mL) at 60 °C for 2 h. The mixture was concentrated in vacuo and the residue diluted with water, washed twice with diethyl ether, and the aqueous layer acidified with 1 N hydrochloric acid. The resulting solution was extracted twice with methylene chloride and the combined organic layers dried (magnesium sulfate), filtered, and concentrated in vacuo. Trituration (hexane) of the residue provided 72 mg (69%) of the title compound as a tan powder. ^{1}H NMR ($CDCl_3$) δ 8.22 (dd, J = 8, 2 Hz, 1H), 7.70 (d, J = 4 Hz, 1H), 7.41 (dt, J = 8, 2 Hz, 1H), 7.35 (s, 1H), 7.18 (m, 3H), 6.82 (d, J = 9 Hz, 1H), 6.69 (d, J = 9 Hz, 1H), 6.62 (d, J = 9 Hz, 1H), 6.55 (s, 1H), 4.22 (t, J = 6 Hz, 2H), 4.21 (t, J = 6 Hz, 2H), 2.57 (m, 4H), 2.35 (quintet, J = 6 Hz, 2H), 1.49 (hextet, J = 8 Hz, 2H), 1.18 (t, J = 7 Hz, 3H), 0.86 (t, J = 7 Hz, 3H); MS ES^+ m/e 534 (p+1); IR (KBr, cm^{-1}) 2957, 1695, 1599, 1457.

Anal. Calcd for $C_{30}H_{31}NO_6S$: C, 67.52; H, 5.86; N, 2.62.
Found: C, 67.44; H, 5.95; N, 2.55.

Example 12

Preparation of 2-(3-{3-[4-(3,5-Dimethylisoxazol-4-yl)-2-ethyl-5-hydroxyphenoxy]propoxy}-2-propylphenoxy)benzoic acid sodium salt.

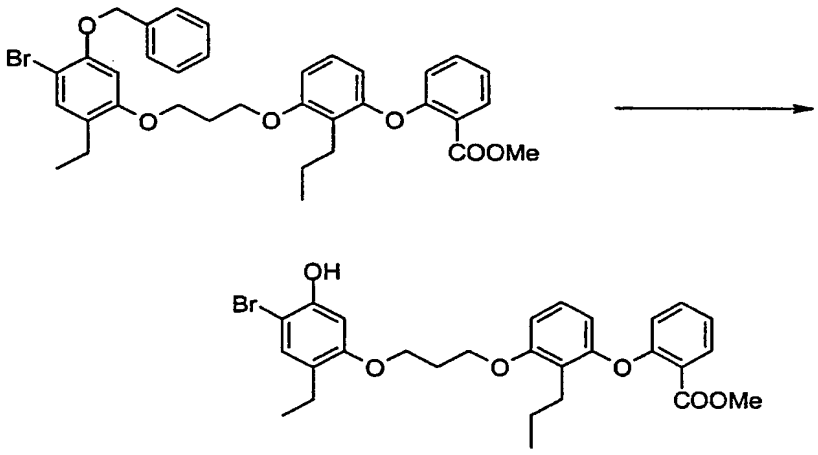


A mixture of 2-(3-{3-[5-benzyloxy-2-ethyl-4-(4,4,5,5-tetramethyl-[1,3,2]dioxaborolan-2-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (305 mg, 0.448 mmol), 3,5-dimethyl-4-iodoisoxazole (110 mg, 0.493 mmol), cesium carbonate (293 mg, 0.899 mmol), and $PdCl_2$(dppf) (15 mg, 0.018 mmol) in de-oxygenated toluene (10 mL) was heated at 95 °C for 10 h. Additional portions of 3,5-dimethyl-4-iodoisoxazole (110 mg), cesium carbonate (260 mg), and $PdCl_2$(dppf) (~15 mg) were added and heating continued at 110 °C for 20 h. The mixture was cooled to room temperature,

concentrated in vacuo, diluted with methylene chloride, and filtered down a short plug of silica gel with 20% ethyl acetate/80% hexane. The filtrate was concentrated in vacuo. The resulting colorless oil was dissolved in methylene chloride (4 mL), cooled to 0 °C, and treated with iodotrimethylsilane (0.40 mL, 2.7 mmol). The resulting mixture was allowed to warm to room temperature and stirred for 18 h. An additional portion of iodotrimethylsilane (0.70 mL) was added and stirring continued for 72 h. The mixture was poured into dilute sodium thiosulfate solution. The organic layer was separated, washed with water, dried (sodium sulfate), filtered, and concentrated in vacuo. The resulting foam was dissolved in a 1:1 mixture of tetrahydrofuran/1 N hydrochloric acid (5 mL) and stirred at room temperature for 18 h. The mixture was concentrated in vacuo and treated with 1 equivalent 1 N sodium hydroxide solution in ether. The resulting mixture was concentrated in vacuo to provide 59 mg (23%) of the title compound as an off-white solid. ^{1}H NMR (DMSO-d_6) δ 7.40 (dd, J = 9, 2 Hz, 1H), 7.13 (dt, J = 8, 2 Hz, 1H), 6.97 (m, 2H), 6.79 (s, 1H), 6.68 (d, J = 9 Hz, 1H), 6.65 (d, J = 9 Hz, 1H), 6.60 (s, 1H), 6.21 (d, J = 8 Hz, 1H), 4.19 (t, J = 6 Hz, 2H), 4.01 (t, J = 6 Hz, 2H), 2.66 (t, J = 8 Hz, 2H), 2.48 (q, J = 8 Hz, 2H), 2.24 (s, 3H), 2.17 (quintet, J = 6 Hz, 2H), 2.07 (s, 3 H), 1.49 (hextet, J = 8 Hz, 2H), 1.07 (t, J = 7 Hz, 3H), 0.85 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{32}H_{36}NO_7$ (p+1): m/z = 546.2492. Found: 546.2514; IR (KBr, cm^{-1}) 3400, 1605, 1460.

Example 13

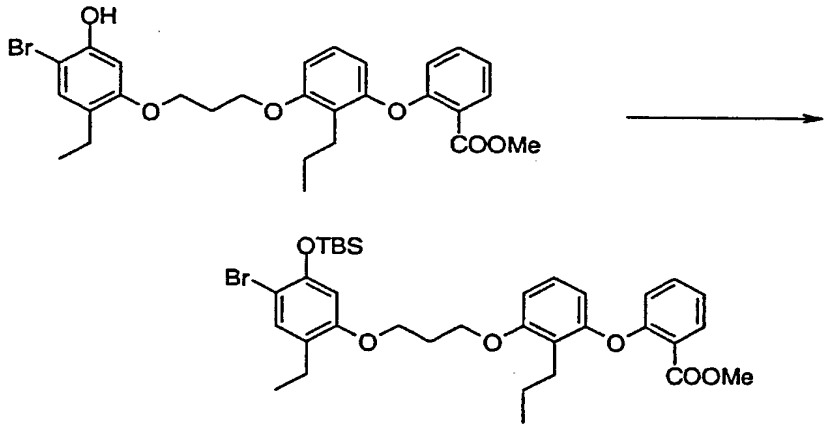
Preparation of 2-{3-[3-(2-Ethyl-4-furan-2-yl-5-hydroxyphenoxy)propoxy]-2-propylphenoxy}-benzoic acid sodium salt.



A. Preparation of 2-{3-[3-(4-bromo-2-ethyl-5-hydroxyphenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A solution of 2-{3-[3-(5-benzyloxy-4-bromo-2-ethylphenoxy)propoxy]-2-propylphenoxy}-benzoic acid methyl ester (2.50 g, 3.95 mmol) in methylene chloride (40 mL) was cooled to -70 °C and treated with boron tribromide (0.25 mL, 2.6 mmol). After 25 min the mixture was poured into cold water and the resulting mixture extracted with methylene chloride. The combined organic extracts were washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo to provide 1.1 g (52%) of the title compound as a pale yellow oil. ^{1}H NMR ($CDCl_3$) δ 7.89 (d, J = 9 Hz, 1H), 7.38 (t, J = 8 Hz, 1H), 7.18 (s 1H), 7.12 (d, J = 9 Hz, 1H), 7.08

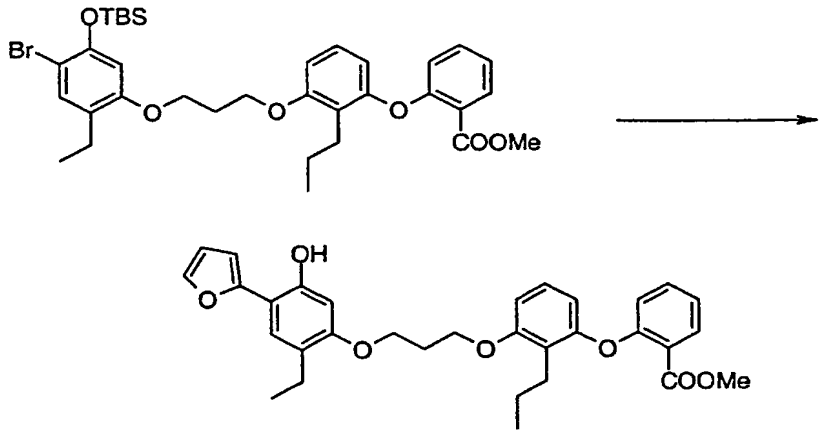
(d, J = 2 Hz, 1H), 6.81 (d, J = 9 Hz, 1H), 6.68 (d, J = 9 Hz, 1H), 6.56 (s, 1H), 6.46 (d, J = 9 Hz, 1H), 5.40 (s, 1H), 4.18 (t, J = 6 Hz, 2H), 4.11 (t, J = 6 Hz, 2H), 3.84 (s, 3H), 2.65 (t, J = 8 Hz, 2H), 2.54 (q, J = 7 Hz, 2H), 2.32 (quintet, J = 6 Hz, 2H), 1.54 (hextet, J = 8 Hz, 2H), 1.13 (t, J = 7 Hz, 3H), 0.89 (t, J = 7 Hz, 3H); MS ES^- m/z = 541 (M - H), 543 (M - H + 2).



B. Preparation of 2-(3-{3-[4-bromo-5-(*tert*-butyldimethylsilanyloxy)-2-ethylphenoxy]-propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A solution of 2-{3-[3-(4-bromo-2-ethyl-5-hydroxyphenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (1.00 g, 1.84 mmol) in methylene chloride (20 mL) was treated with imidazole (0.19 g, 2.8 mmol) and *tert*-butyldimethylsilyl chloride (0.388 g, 2.57 mmol) at room temperature for 2 h. The mixture was poured into water and the organic layer separated, washed once with water, once with saturated sodium chloride solution, filtered through a short pad of silica gel, and concentrated in vacuo to

provide 1.1 g (91%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.88 (d, J = 9 Hz, 1H), 7.38 (t, J = 8 Hz, 1H), 7.22 (s 1H), 7.12 (d, J = 9 Hz, 1H), 7.08 (d, J = 2 Hz, 1H), 6.80 (d, J = 9 Hz, 1H), 6.69 (d, J = 9 Hz, 1H), 6.45 (d, J = 9 Hz, 1H), 6.40 (s, 1H), 4.20 (t, J = 6 Hz, 2H), 4.11 (t, J = 6 Hz, 2H), 3.83 (s, 3H), 2.64 (t, J = 8 Hz, 2H), 2.54 (q, J = 7 Hz, 2H), 2.32 (quintet, J = 6 Hz, 2H), 1.54 (hextet, J = 8 Hz, 2H), 1.13 (t, J = 7 Hz, 3H), 1.03 (s, 9H), 0.89 (t, J = 7 Hz, 3H), 0.23 (s, 6H).

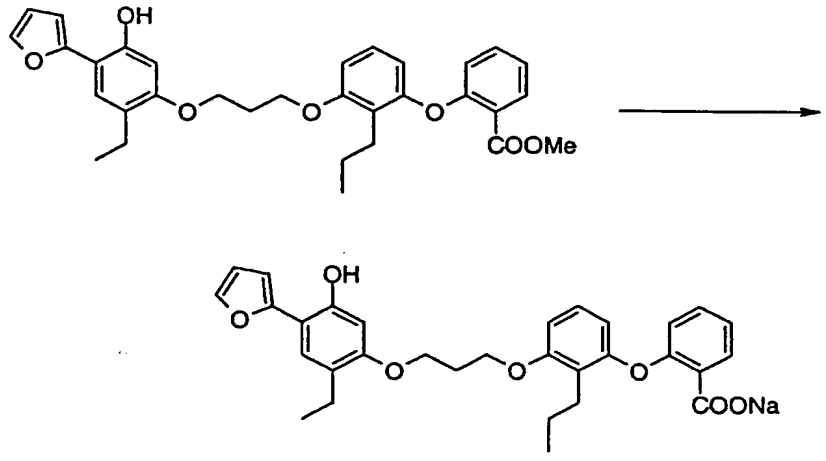


C. Preparation of 2-{3-[3-(2-ethyl-4-furan-2-yl-5-hydroxyphenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester.

A mixture of 2-(3-{3-[4-bromo-5-(*tert*-butyldimethylsilanyloxy)-2-ethylphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (1.05 g, 1.60 mmol), furan-2-boronic acid (0.358 g, 3.20 mmol), tetrakis(triphenylphosphine)palladium(0) (0.185 g, 0.160 mmol), and 2 M aqueous sodium carbonate solution (8 mL) in

tetrahydrofuran (20 mL) was heated at reflux for 18 h. The mixture was cooled to room temperature, diluted with water, and extracted with ethyl acetate. The organic layer was separated, washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 0.8 g (94%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.90 (d, J = 9 Hz, 1H), 7.48 (s, 1H), 7.38 (t, J = 8 Hz, 1H), 7.21 (s 1H), 7.13 (s, 1H), 7.10 (d, J = 9 Hz, 1H), 7.07 (d, J = 2 Hz, 1H), 6.81 (d, J = 9 Hz, 1H), 6.69 (d, J = 9 Hz, 1H), 6.52 (m, 3H), 6.44 (d, J = 9 Hz, 1H), 4.20 (m, 4H), 3.83 (s, 3H), 2.67 (t, J = 8 Hz, 2H), 2.59 (q, J = 7 Hz, 2H), 2.32 (quintet, J = 6 Hz, 2H), 1.55 (hextet, J = 8 Hz, 2H), 1.18 (t, J = 7 Hz, 3H), 0.91 (t, J = 7 Hz, 3H); MS ES^- m/z = 589 (p + AcO^-).

Anal. Calcd for $C_{32}H_{34}O_7$: C, 72.43; H, 6.46. Found: C, 72.21; H, 6.15.

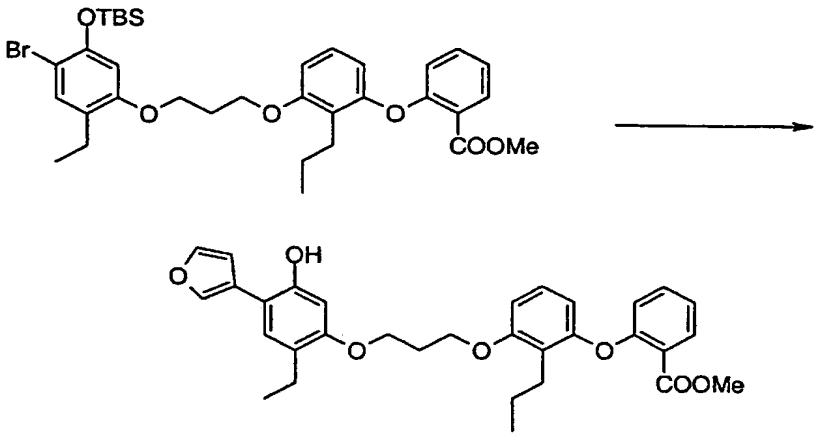


D. Preparation of 2-{3-[3-(2-ethyl-4-furan-2-yl-5-hydroxyphenoxy)propoxy]-2-propylphenoxy}benzoic acid sodium salt.

2-{3-[3-(2-Ethyl-4-furan-2-yl-5-hydroxyphenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (250 mg, 0.47 mmol) was dissolved in tetrahydrofuran (4 mL) and treated with 1 N lithium hydroxide solution (2 mL) at 50 °C for 16 h. The mixture was concentrated in vacuo and the residue diluted with water and extracted twice with ethyl acetate. The combined organic extracts were washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. The residue was dissolved in ethyl acetate and shaken with 1 N hydrochloric acid. The organic layer was dried (sodium sulfate), filtered, and concentrated in vacuo. The residue was dissolved in diethyl ether and treated with 1 N aqueous sodium hydroxide solution (0.32 mL). The mixture was concentrated in vacuo and azeotroped successively with diethyl ether, chloroform, and diethyl ether and dried to provide 168 mg (66%) of the title product as a cream solid. ^{1}H NMR (DMSO-d_6) δ 7.56 (s, 1H), 7.44 (d, J = 8 Hz, 1H), 7.35 (s, 1H), 7.13 (m, 1H), 6.97 (m, 2H), 6.77 (d, J = 2 Hz, 1H), 6.65 (m, 4H), 6.48 (d, J = 2 Hz, 1H), 6.24 (d, J = 9 Hz, 1H), 4.15 (t, J = 6 Hz, 2H), 3.96 (t, J = 6 Hz, 2H), 2.66 (t, J = 8 Hz, 2H), 2.42 (q, J = 7 Hz, 2H), 2.13 (quintet, J = 6 Hz, 2H), 1.48 (hextet, J = 8 Hz, 2H), 1.09 (t, J = 7 Hz, 3H), 0.84 (t, J = 7 Hz, 3H); TOF MS ES$^+$ exact mass calculated for $C_{31}H_{33}O_7$ (p+1): m/z = 517.2226. Found: 517.2230. IR (KBr, cm^{-1}) 3400, 2961, 1599, 1460.

Example 14

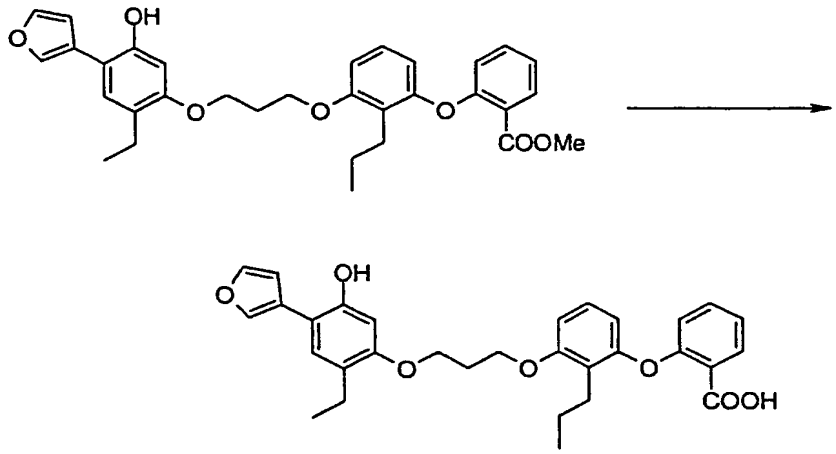
Preparation of 2-(3-{3-[2-Ethyl-5-hydroxy-4-furan-3-yl]phenoxy]propoxy}-2-propylphenoxy)benzoic acid.



A. Preparation of 2-{3-[3-(2-ethyl-4-furan-3-yl-5-hydroxyphenoxy)propoxy]-2-propyl-phenoxy}benzoic acid methyl ester.

A mixture of 2-(3-{3-[4-bromo-5-(*tert*-butyldimethylsilanyloxy)-2-ethylphenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (2.10 g, 3.19 mmol), furan-3-boronic acid (0.722 g, 6.45 mmol), tetrakis(triphenylphosphine)palladium(0) (0.37 g, 0.32 mmol), and 2 M aqueous sodium carbonate solution (16 mL) in tetrahydrofuran (30 mL) was heated at reflux for 48 h. The mixture was cooled to room temperature, diluted with water, and extracted with ethyl acetate. The organic layer was separated, washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 15% ethyl acetate/85% hexane) of the residue provided 0.29 g

(17%) of the title compound as a yellow oil. TOF MS ES^+ exact mass calculated for $C_{32}H_{35}O_7$ (p+1): m/z = 531.2383. Found: 531.2396.



B. Preparation of 2-{3-[3-(2-ethyl-4-furan-3-yl-5-hydroxyphenoxy)propoxy]-2-propylphenoxy}benzoic acid sodium salt.

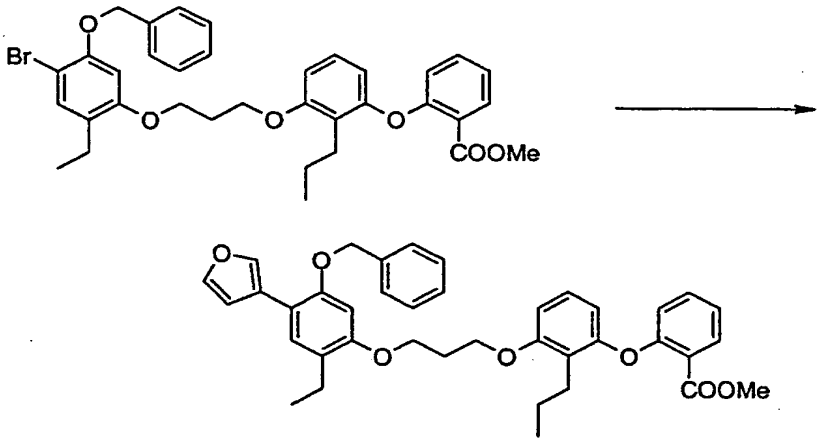
2-{3-[3-(2-Ethyl-4-furan-3-yl-5-hydroxyphenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester (170 mg, 0.32 mmol) was dissolved in tetrahydrofuran (4 mL) and methanol (1 mL) and treated with 1 N lithium hydroxide solution (4 mL) at 50 °C for 2 h. The mixture was concentrated in vacuo and the residue acidified with hydrochloric acid and the resulting mixture extracted twice with ethyl acetate. The combined organic extracts were washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 2% methanol/98% chloroform) of the residue gave 45 mg of material that was again submitted to chromatography

(silica gel, 1% methanol/99% chloroform) to provide 25 mg (15%) of the title compound as an oil.

TOF MS ES^+ exact mass calculated for $C_{31}H_{33}O_7$ (p+1): m/z = 517.226. Found: 517.2230.

Example 15

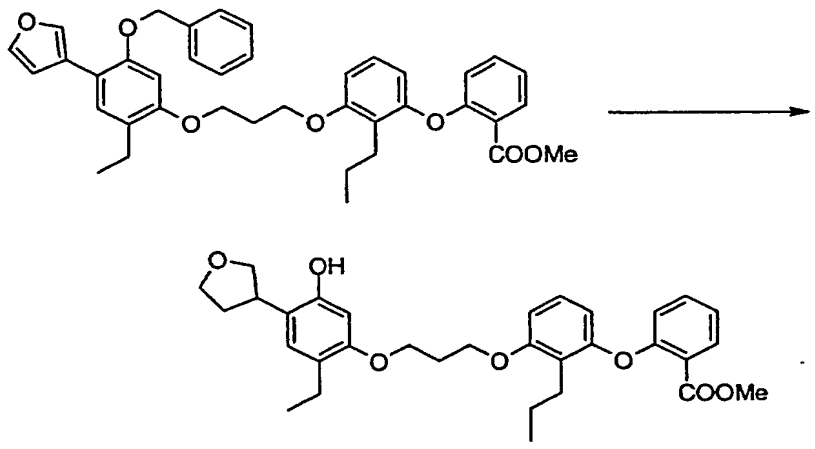
Preparation of 2-(3-{3-[2-Ethyl-5-hydroxy-4-(tetrahydrofuran-3-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid sodium salt hemihydrate.



A. Preparation of 2-{3-[3-(5-benzyloxy-2-ethyl-4-furan-3-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester.

A mixture of 2-{3-[3-(5-benzyloxy-4-bromo-2-ethylphenoxy)propoxy]-2-propylphenoxy}-benzoic acid methyl ester (3.00 g, 4.73 mmol), furan-3-boronic acid (1.06 g, 9.47 mmol), tetrakis(triphenylphosphine)palladium(0) (0.54 g, 0.47 mmol), and 2 M aqueous sodium carbonate solution (20 mL) in tetrahydrofuran (40 mL) was heated at 100 °C for 48 h. The mixture was cooled to room temperature, diluted with water, and extracted with ethyl acetate. The organic layer

was separated, washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 1.9 g (65%) of the title compound as a yellow oil. ^{1}H NMR ($CDCl_3$) δ 7.88 (dd, J = 8, 2 Hz, 1H), 7.87 (s, 1H), 7.40 (m, 7H), 7.26 (s 1H), 7.05 (m, 2H), 6.80 (d, J = 9 Hz, 1H), 6.76 (d, J = 2 Hz, 1H), 6.67 (d, J = 9 Hz, 1H), 6.60 (s, 1H), 6.43 (d, J = 9 Hz, 1H), 5.11 (s, 2H), 4.18 (m, 4H), 3.83 (s, 3H), 2.66 (t, J = 8 Hz, 2H), 2.62 (q, J = 7 Hz, 2H), 2.30 (quintet, J = 6 Hz, 2H), 1.57 (hextet, J = 8 Hz, 2H), 1.20 (t, J = 7 Hz, 3H), 0.92 (t, J = 7 Hz, 3H); MS ES$^+$ m/z = 621 (p + 1); IR ($CHCl_3$, cm^{-1}) 3000, 1727, 1603, 1461.

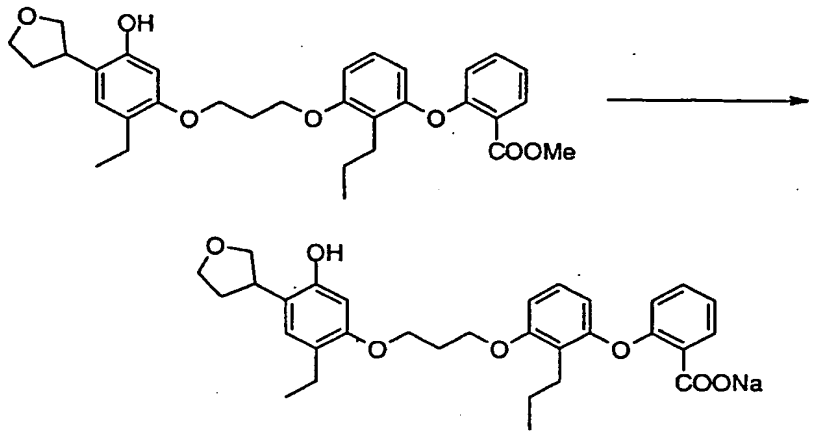


B. Preparation of 2-(3-{3-[2-ethyl-5-hydroxy-4-(tetrahydrofuran-3-yl)phenoxy]-propoxy}-2-propylphenoxy)benzoic acid methyl ester.

A solution of 2-{3-[3-(5-benzyloxy-2-ethyl-4-furan-3-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid methyl ester

(1.8 g, 2.9 mmol) in ethyl acetate (40 mL) was treated with 10% palladium-on-carbon (0.39 g) and hydrogenated at 48 psi and 45 °C for 72 h. The mixture was cooled to room temperature, filtered through Celite™, and the filtrate concentrated in vacuo to provide 1.2 g (77%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.88 (dd, J = 8, 2 Hz, 1H), 7.57 (dt, J = 8, 2 Hz, 1H), 7.09 (d, J = 9 Hz, 1H), 7.04 (d, J = 9 Hz, 1H), 6.81 (d, J = 9 Hz, 1H), 6.80 (s, 1H), 6.67 (d, J = 9 Hz, 1H), 6.44 (d, J = 9 Hz, 1H), 6.43 (s, 1H), 4.19 (m, 3H), 4.10 (m, 2H), 4.02 (dd, J = 12, 3 Hz, 1H), 3.88 (dd, J = 12, 8 Hz, 1H), 3.84 (s, 3H), 3.73 (q, J = 9 Hz, 1H), 3.45 (m, 1H), 2.64 (t, J = 8 Hz, 2H), 2.53 (q, J = 7 Hz, 2H), 2.38 (m, 1H), 2.28 (quintet, J = 6 Hz, 2H), 1.99 (m, 1H), 1.55 (hextet, J = 8 Hz, 2H), 1.15 (t, J = 7 Hz, 3H), 0.90 (t, J = 7 Hz, 3H); MS ES$^-$ m/z = 593 (p + CH_3COO^-); IR ($CHCl_3$, cm^{-1}) 2963, 1719, 1589, 1461.

Anal. Calcd for $C_{32}H_{38}O_7$: C, 71.89; H, 7.16. Found: C, 71.41; H, 7.06.



C. Preparation of 2-(3-{3-[2-ethyl-5-hydroxy-4-(tetrahydrofuran-3-yl)phenoxy]-propoxy}-2-propylphenoxy)benzoic acid sodium salt hemihydrate.

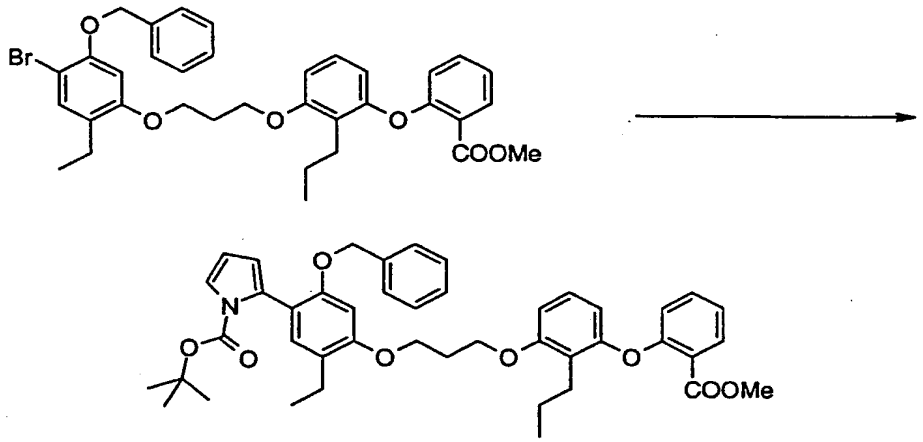
A solution of 2-(3-{3-[2-ethyl-5-hydroxy-4-(tetrahydrofuran-3-yl)phenoxy]propoxy}-2-propylphenoxy)benzoic acid methyl ester (0.92 g, 1.7 mmol) in tetrahydrofuran (10 mL) and methanol (5 mL) was treated with 1 M aqueous lithium hydroxide solution (10 mL) at 55 °C for 2 h. The mixture was allowed to cool to room temperature and stirred for an additional 18 h. The mixture was concentrated in vacuo and the remaining aqueous mixture was washed once with diethyl ether. The aqueous layer was acidified with concentrated hydrochloric acid and the resulting solution extracted with ethyl acetate. The ethyl acetate layer was washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. The resulting colorless oil was dissolved in diethyl ether and treated with 1 N aqueous sodium hydroxide solution (1.72 mL). The resulting biphasic mixture was diluted with chloroform and concentrated in vacuo. Diethyl ether was added and the mixture concentrated in vacuo. The resulting white foam was dried in vacuo at room temperature for 60 h to provide 0.78 g (84%) of the title compound: mp 67-71 °C. ^{1}H NMR (DMSO-d_6) δ 7.62 (dd, J = 8, 2 Hz, 1H), 7.30 (dt, J = 8, 2 Hz, 1H), 7.05 (m, 2H), 6.85 (s, 1H), 6.73 (d, J = 9 Hz, 1H), 6.70 (d, J = 9 Hz, 1H), 6.53 (s, 1H), 6.34 (d, J = 9 Hz, 1H), 4.15 (t, J = 6 Hz, 2H), 4.04 (t, J = 6 Hz, 2H), 3.95 (m, 1H), 3.88 (m, 1H), 3.75 (q, J = 9 Hz, 1H), 3.49 (m 2H), 2.60 (t, J = 8 Hz, 2H), 2.45 (q, J = 7 Hz, 2H), 2.15 (m, 3H), 1.90 (m, 1H), 1.48 (hextet, J = 8 Hz, 2H), 1.06 (t,

J = 7 Hz, 3H), 0.83 (t, J = 7 Hz, 3H); MS ES$^-$ m/z = 519 (p - Na^+); IR ($CHCl_3$, cm^{-1}) 2964, 1783, 1604, 1461.

Anal. Calcd for $C_{31}H_{35}NaO_7 \cdot 0.5\ H_2O$: C, 67.50; H, 6.58. Found: C, 67.76; H, 6.68.

Example 16

Preparation of 2-{3-[3-(2-Ethyl-5-hydroxy-4-pyrrolidin-2-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid hydrochloride hydrate.

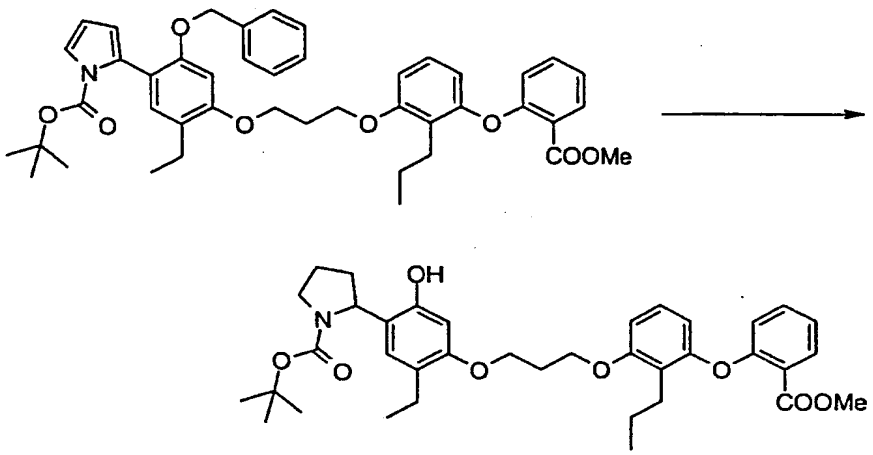


A. Preparation of 2-(2-benzyloxy-5-ethyl-4-{3-[3-(2-methoxycarbonylphenoxy)-2-propylphenoxy]propoxy}phenyl)pyrrole-1-carboxylic acid *tert*-butyl ester.

A mixture of 2-{3-[3-(5-benzyloxy-4-bromo-2-ethylphenoxy)propoxy]-2-propylphenoxy}-benzoic acid methyl ester (3.00 g, 4.73 mmol), N-boc pyrrole-2-boronic acid (1.99 g, 9.43 mmol), tetrakis(triphenylphosphine)palladium(0) (0.54 g, 0.47 mmol), and 2 M aqueous sodium carbonate solution (25 mL) in

tetrahydrofuran (60 mL) was heated at reflux for 40 h. The mixture was cooled to room temperature, diluted with water, and extracted with ethyl acetate. The organic layer was separated, washed once with water, once with saturated sodium chloride solution, dried (sodium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 10% ethyl acetate/90% hexane) of the residue provided 2.6 g (76%) of the title compound as a solid. ^{1}H NMR ($CDCl_3$) δ 7.88 (dd, J = 8, 2 Hz, 1H), 7.15-7.40 (m, 7H), 7.08 (m, 3H), 6.82 (d, J = 9 Hz, 1H), 6.68 (d, J = 9 Hz, 1H), 6.52 (s, 1H), 6.44 (d, J = 9 Hz, 1H), 6.23 (t, J = 4 Hz, 1H), 6.12 (m, 1H), 4.95 (s, 2H), 4.20 (t, J = 6 Hz, 2H); 4.15 (t, J = 6 Hz, 2H), 3.84 (s, 3H), 2.66 (t, J = 8 Hz, 2H), 2.60 (q, J = 7 Hz, 2H), 2.30 (quintet, J = 6 Hz, 2H), 1.57 (hextet, J = 8 Hz, 2H), 1.28 (s, 9H), 1.18 (t, J = 7 Hz, 3H), 0.93 (t, J = 7 Hz, 3H); TOS MS ES$^+$ exact mass calculated for $C_{44}H_{53}N_2O_8$ (p + NH_4^+): m/z = 737.3802. Found: 737.3804; IR ($CHCl_3$, cm^{-1}) 2964, 1730, 1461.

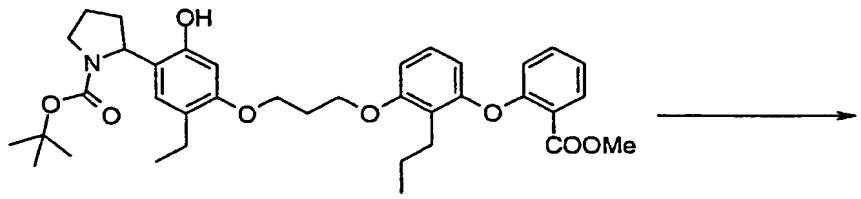
Anal. Calcd for $C_{44}H_{49}NO_8$: C, 73.41; H, 6.86; N, 1.94. Found: C, 73.76; H, 6.76; N, 2.04.

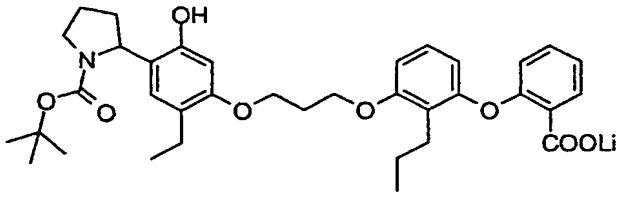


B. Preparation of 2-(5-ethyl-2-hydroxy-4-{3-[3-(2-methoxycarbonylphenoxy)-2-propylphenoxy]propoxy}phenyl)-pyrrolidine-1-carboxylic acid *tert*-butyl ester.

A solution of 2-(2-benzyloxy-5-ethyl-4-{3-[3-(2-methoxycarbonylphenoxy)-2-propylphenoxy]propoxy}phenyl)pyrrole-1-carboxylic acid *tert*-butyl ester (0.98 g, 1.4 mmol) in ethyl acetate (40 mL) was treated with 10% palladium-on-carbon (0.98 g) and hydrogenated at 45 psi and 45 °C for 25 h, at room temperature for 20 h, then at 45 °C for 19 h. The mixture was cooled to room temperature, filtered through Celite™, and the filtrate concentrated in vacuo to provide 0.76 g (88%) of the title compound as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.87 (dd, J = 8, 2 Hz, 1H), 7.37 (dt, J = 8, 2 Hz, 1H), 7.10 (d, J = 9 Hz, 1H), 7.04 (d, J = 9 Hz, 1H), 6.91 (s, 1H), 6.81 (d, J = 9 Hz, 1H), 6.67 (d, J = 9 Hz, 1H), 6.47 (s, 1H), 6.44 (d, J = 9 Hz, 1H), 5.09 (m, 1H), 4.18 (d, J = 6 Hz, 2H), 4.14 (t, J = 6 Hz, 2H), 3.84 (s, 3H), 3.45 (m, 2H), 2.64 (t, J = 8 Hz, 2H), 2.54 (m, 3H), 2.25 (m, 5H),

2.06 (m, 1H), 1.54 (hextet, J = 8 Hz, 2H), 1.43 (s, 9H), 1.15 (t, J = 7 Hz, 3H), 0.90 (t, J = 7 Hz, 3H).



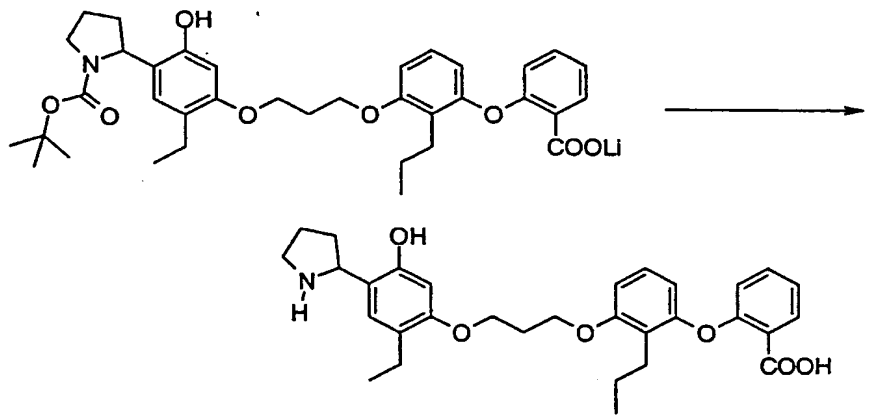


C. Preparation of 2-(4-{3-[3-(2-carboxyphenoxy)-2-propylphenoxy]propoxy}-5-ethyl-2-hydroxyphenyl)pyrrolidine-1-carboxylic acid tert-butyl ester lithium salt hydrate.

A solution of 2-(5-ethyl-2-hydroxy-4-{3-[3-(2-methoxycarbonylphenoxy)-2-propylphenoxy]propoxy}phenyl)pyrrolidine-1-carboxylic acid *tert*-butyl ester (0.114 g, 0.18 mmol) in a 1:1 mixture of methanol/tetrahydrofuran (4 mL) was treated with solution of 1 M lithium hydroxide (4 mL) at room temperature for 18 h. The mixture was concentrated in vacuo and the residue dissolved in water. The resulting mixture was extracted with ethyl acetate. The organic extract was dried (sodium sulfate), filtered, and concentrated in vacuo. The residue was diluted with diethyl ether, concentrated in vacuo, and dried to provide 90 mg (78%) of the title compound. MS ES^+

m/z = 620 (p + 1 - Li^+); IR (KBr, cm^{-1}) 2964, 1672, 1603, 1416.

Anal. Calcd for $C_{36}H_{44}NO_8Li \cdot H_2O$: C, 67.17; H, 7.20; N, 2.18. Found: C, 66.72; H, 6.99; N, 2.27.



D. Preparation of 2-{3-[3-(2-ethyl-5-hydroxy-4-pyrrolidin-2-yl-phenoxy)propoxy]-2-propylphenoxy}benzoic acid hydrochloride hydrate.

Into a solution of 2-(4-{3-[3-(2-carboxyphenoxy)-2-propylphenoxy]propoxy}-5-ethyl-2-hydroxyphenyl)pyrrolidine-1-carboxylic acid tert-butyl ester lithium salt hydrate (0.100 g, 0.16 mmol) in anhydrous diethyl ether (5 mL) was bubbled gaseous HCl. The resulting mixture was allowed to stir for 1 h. The mixture was concentrated in vacuo. Chromatography (SCX cation exchange resin, 1:1 tetrahydrofuran/methanol to dilute ammonia/methanol) of the residue provided a tan solid. This material was dissolved in ether and treated with gaseous HCl. This mixture was concentrated in vacuo to provide 48 mg (52%) of the title compound. ^1H NMR (DMSO-d_6) δ 12.80 (bs, 1H), 10.12 (s, 1H),

9.34 (bs, 1H), 8.36 (bs, 1H), 7.79 (dd, J = 9, 2 Hz, 1H), 7.47 (dt, J = 8, 2 Hz, 1H), 7.17 (t, J = 8 Hz, 1H), 7.12 (d, J = 9 Hz, 1H), 7.07 (s, 1H), 6.80 (d, J = 9 Hz, 1H), 6.78 (d, J = 9 Hz, 1H), 6.58 (s, 1H), 6.35 (d, J = 9 Hz, 1H), 4.56 (m, 1H), 4.20 (t, J = 6 Hz, 2H); 4.11 (t, J = 6 Hz, 2H), 3.25 (m, 2H), 2.50 (m, 5H), 1.90-2.60 (m, 5H), 1.44 (hextet, J = 8 Hz, 2H), 1.08 (t, J = 7 Hz, 3H), 0.82 (t, J = 7 Hz, 3H); TOS MS ES^+ exact mass calculated for $C_{31}H_{38}NO_6$ (p + 1): m/z = 520.2699. Found: 520.2672.

Example 17

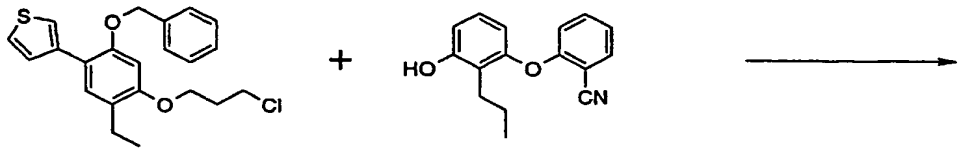
Preparation of 2-{3-[3-(2-Ethyl-5-hydroxy-4-thiophen-3-yl-phenoxy)propoxy]-2-propyl-phenoxy}benzoic acid hydrate.

Known compound:
Sawyer et al., *J. Med. Chem.* **1995**, *38*, 4411.

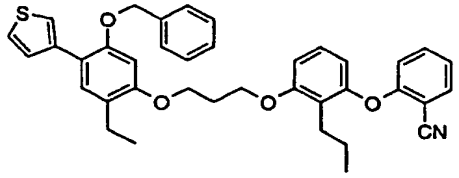
A. Preparation of 3-[2-benzyloxy-4-(3-chloropropoxy)-5-ethylphenyl]thiophene. A mixture of 4-(benzyloxy)-5-bromo-2-(3-chloropropoxy)ethylbenzene (1.90 g, 5.30 mmol), 3-thiopheneboronic acid (2.00 g, 15.9 mmol), tetrakis(triphenylphosphine)palladium(0) (312 mg, 0.270 mmol), 2 M aqueous sodium carbonate solution (4 mL), and *n*-propanol (4 mL) in toluene (16 mL) was refluxed for 4 h. The mixture was cooled to room temperature, diluted with diethyl ether, washed once with water and once with

saturated sodium chloride solution. The organic layer was dried (magnesium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 5% ethyl acetate/95% hexane) of the residue provided 1.54 g (80%) of the title product as a white solid: mp 65-67 °C. ^{1}H NMR ($CDCl_3$) δ 7.58 (d, J = 2.8 Hz, 1H), 7.49 (d, J = 5.2 Hz, 1H), 7.45-7.30 (m, 7H), 6.62 (s, 1H), 5.13 (s, 2H), 4.14 (t, J = 5.8 Hz, 2H), 3.81 (t, J = 6.3 Hz, 2H), 2.66 (q, J = 7.5 Hz, 2H), 2.29 (quintet, J = 6.0 Hz, 2H), 1.24 (t, J = 7.5 Hz, 3H); MS FD m/e 386 (p); IR ($CHCl_3$, cm^{-1}) 2969, 1613, 1501, 1138.

Anal. Calcd for $C_{22}H_{23}O_2ClS$: C, 68.29; H, 5.99. Found: C, 68.53; H, 6.00.



Known compound:
Sawyer et al.,
J. Med. Chem. 1995, 38, 4411.

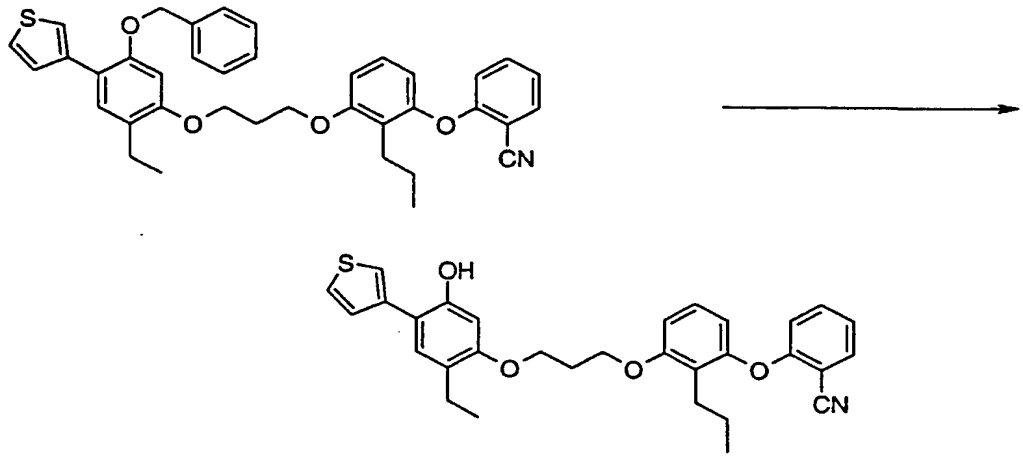


B. **Preparation of 2-[2-propyl-3-[3-[5-(benzyloxy)-2-ethyl-4-(thiophen-3-yl)phenoxy]propoxy]phenoxy]benzonitrile.**

A mixture of 4-(benzyloxy)-2-(3-chloropropoxy)-5-(thiophen-3-yl)ethylbenzene (1.25 g, 3.23 mmol), 3-(2-cyanophenoxy)-2-propylphenol (0.82 g, 3.2 mmol), potassium iodide (0.21 g,

1.3 mmol), potassium carbonate (1.12 g, 8.08 mmol), and methyl sulfoxide (2 mL) in 2-butanone (10 mL) was refluxed for 60 h. The mixture was cooled to room temperature, diluted with ether, and washed with water. The organic layer was dried (magnesium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 5% ethyl acetate/95% hexane) of the residue provided 1.31 g (67%) of the title product as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.66 (d, J = 7.8 Hz, 1H), 7.57 (d, J = 2.9 Hz, 1H), 7.48 (d, J = 5.2 Hz, 1H), 7.45-7.25 (m, 8H), 7.20 (t, J = 8.2 Hz, 1H), 7.10 (t, J = 8.1 Hz, 1H), 6.82 (d, J = 8.3 Hz, 1H), 6.77 (d, J = 8.6 Hz, 1H), 6.64 (s, 1H), 6.63 (d, J = 6.4 Hz, 1H), 5.11 (s, 2H), 4.26 (t, J = 6.0 Hz, 2H), 4.22 (t, J = 6.0 Hz, 2H), 2.65 (m, 4H), 2.36 (quintet, J = 5.9 Hz, 2H), 1.58 (hextet, J = 7.5 Hz, 2H), 1.24 (t, J = 7.5 Hz, 3H), 0.95 (t, J = 7.3 Hz, 3H); MS FD m/e 603 (p); IR ($CHCl_3$, cm^{-1}) 2967, 2250, 1613, 1501. Anal. Calcd for $C_{38}H_{37}NO_4S$: C, 75.59; H, 6.18; N, 2.32. Found: C, 74.65; H, 6.21; N, 2.57.

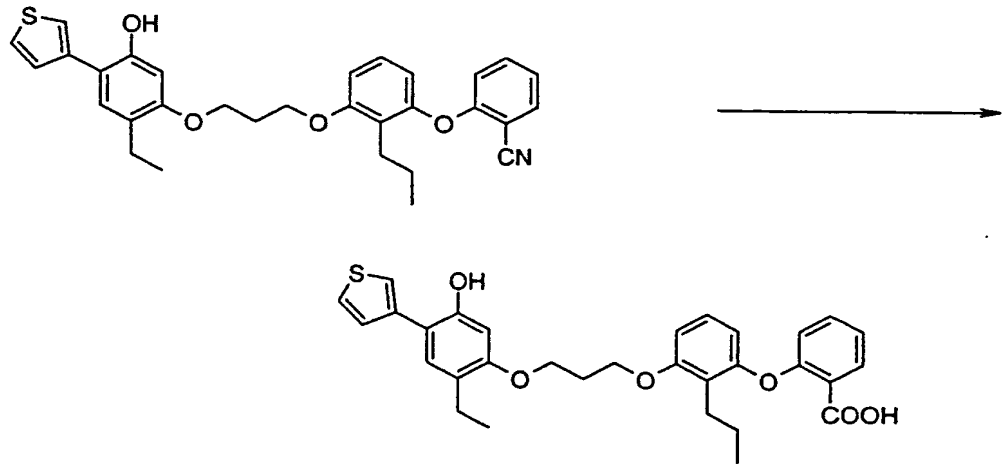
C. Preparation of 2-[2-propyl-3-[3-[2-ethyl-5-hydroxy-4-(thiophen-3-yl)phenoxy]propoxy]phenoxy]benzonitrile.



To a solution of 2-[2-propyl-3-[3-[5-(benzyloxy)-2-ethyl-4-(thiophen-3-yl)phenoxy]propoxy]phenoxy]benzonitrile (900 mg, 1.49 mmol) in methylene chloride (25 mL) cooled to -78 °C was added 1 M boron tribromide solution in methylene chloride (2.99 mL, 2.99 mmol) over 2 min. The resulting deep violet solution was stirred for 30 min and allowed to warm to room temperature. The mixture was diluted with water and shaken. The organic layer was separated, dried (magnesium sulfate), filtered, and concentrated in vacuo. Chromatography (silica gel, 25% ethyl acetate, 75% hexane) provided 400 mg (52%) of the title product as a colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.84 (d, J = 4.8 Hz, 1H), 7.71 (d, J = 4.9 Hz, 1H), 7.66 (d, J = 7.7 Hz, 1H), 7.62 (s, 1H), 7.42 (t, J = 7.1 Hz, 1H), 7.27 (t, J = 6.6 Hz, 1H), 7.20 (s, 1H), 7.08 (t, J = 6.9 Hz, 1H), 6.85 (s, 1H), 6.89 (d, J = 8.1 Hz, 1H), 6.74 (d, J = 8.5 Hz, 1H), 6.60 (d, J = 7.6 Hz, 1H), 4.71 (s, 1H, -OH), 4.26 (t, J = 6.0 Hz, 4H), 2.72 (q, J = 7.4 dHz, 2H), 2.59 (t, J = 7.3 Hz, 2H), 2.39 (quintet, J =

6.1 Hz, 2H), 1.54 (hextet, J = 7.7 Hz, 2H), 1.25 (t, J = 7.5 Hz, 3H), 0.91 (t, J = 7.4 Hz, 3H).

D. Preparation of 2-[2-propyl-3-[3-[2-ethyl-5-hydroxy-4-(thiophen-3-yl)phenoxy]propoxy]phenoxy]benzoic acid hydrate.



A solution of 2-[2-propyl-3-[3-[2-ethyl-5-hydroxy-4-(thiophen-3-yl)phenoxy]propoxy]phenoxy]benzonitrile (400 mg, 0.780 mmol) in 2:1 methanol/water (6 mL) was treated with 12.5 M aqueous sodium hydroxide (4.0 mL) at reflux for 36 h. The mixture was cooled to room temperature, diluted with water, and extracted once with diethyl ether. The aqueous layer was acidified with concentrated hydrochloric acid and extracted twice with methylene chloride. The combined methylene chloride layers were dried (magnesium sulfate), filtered, and concentrated in vacuo to provide a tan solid: mp 90-95 °C (dec). ^{1}H NMR ($CDCl_3$) δ 8.24 (d, J = 7.8 Hz, 1H), 7.47 (d, J = 5.0 Hz, 1H), 7.44 (t, J = 8.6 Hz, 1H), 7.36 (d, J = 3 Hz, 1H), 7.24 (d, J = 4.9 Hz, 1H), 7.19 (m, 2H), 7.09 (s, 1H), 6.84 (d, J = 8.0 Hz, 1H), 6.73 (d, J = 8.3 Hz, 1H), 6.64 (d, J = 8.0 Hz, 1H), 6.55 (s, 1H), 5.38 (bs, 1H, -OH), 4.26 (t, J = 6.2 Hz, 2H), 4.21 (t, J = 7.1

Hz, 2H), 2.60 (m, 4H), 2.36 (quintet, J = 5.8 Hz, 2H), 1.51 (hextet, J = 7.1 Hz, 2H), 1.19 (t, J = 7.5 Hz, 3H), 0.90 (t, J = 7.4 Hz, 3H); MS FD m/e 532 (p); IR (KBr, cm^{-1}) 3200 (br), 2961, 1697, 1457, 1110. Anal. Calcd for $C_{31}H_{32}O_6S \cdot H_2O$: C, 67.62; H, 6.22. Found: C, 67.34; H, 5.87.

The previously described LTB_4 antagonists and anti-cangel agents used in the composition and method of the invention are often advantageously used in the form of salt derivatives which are an additional aspect of the invention. When compounds of the invention possess an Acidic Group(s) or other reactive group, salts may be formed which are more water soluble and/or physiologically suitable than the parent compound in its acid form. Representative pharmaceutically acceptable salts, include but are not limited to, the alkali and alkaline earth salts such as lithium, sodium, potassium, calcium, magnesium, aluminum and the like. Sodium salts are particularly preferred. Salts are conveniently prepared from the free acid by treating the acid form in solution with a base or by exposing the acid to an ion exchange resin. For example, the (Acidic Group) of the Z of Formula (I) may be selected as $-CO_2H$ and salts may be formed by reaction with appropriate bases (e.g., NaOH, KOH) to yield the corresponding sodium or potassium salt.

Included within the definition of pharmaceutically acceptable salts are the relatively non-toxic, inorganic and organic base addition salts of compounds of the present invention, for example, ammonium, quaternary ammonium, and amine cations, derived from nitrogenous bases of sufficient basicity to form salts with the LTB_4 antagonist compounds of this invention (see, for example, S. M. Berge, *et al.*,

"Pharmaceutical Salts," J. Phar. Sci., 66: 1-19 (1977)). Certain compounds of the invention may possess one or more chiral centers and may thus exist in optically active forms. All such stereoisomers as well as the mixtures thereof are intended to be included in the invention. If a particular stereoisomer is desired, it can be prepared by methods well known in the art, for example, by using stereospecific reactions with starting materials which contain the asymmetric centers and are already resolved or, alternatively, by methods which lead to mixtures of the stereoisomers and subsequent resolution by known methods. For example, a racemic mixture may be reacted with a single enantiomer of some other compound. This changes the racemic form into a mixture of diastereomers. Then, because the diastereomers have different melting points, different boiling points, and different solubilities, they can be separated by conventional means, such as crystallization.

Prodrugs are derivatives of the LTB_4 antogonist and anti-cancer compounds used in the invention which have chemically or metabolically cleavable groups and become by solvolysis or under physiological conditions the compounds of the invention which are pharmaceutically active in vivo. Derivatives of the compounds of this invention have activity in both their acid and base derivative forms, but the acid derivative form often offers advantages of solubility, tissue compatibility, or delayed release in a mammalian organism (see, Bundgard, H., Design of Prodrugs, pp. 7-9, 21-24, Elsevier, Amsterdam 1985). Prodrugs include acid derivatives well known to practitioners of the art, such as, for example, esters prepared by reaction of the parent acidic compound with a suitable alcohol, or amides prepared by reaction of the parent acid compound with a suitable

amine. Simple aliphatic or aromatic esters derived from acidic groups pendent on the compounds of this invention are preferred prodrugs. In some cases it is desirable to prepare double ester type prodrugs such as (acyloxy) alkyl esters or ((alkoxycarbonyl)oxy)alkyl esters. Particularly preferred esters as prodrugs are methyl, ethyl, propyl, isopropyl, n-butyl, isobutyl, tert-butyl, morpholinoethyl, and N,N-diethylglycolamido.

Esters of carboxylic acids are preferred prodrugs of the compounds of the composition of the invention.

Methyl ester prodrugs may be prepared by reaction of the acid form of a compound of formula (I) in a medium such as methanol with an acid or base esterification catalyst (e.g., NaOH, H_2SO_4). Ethyl ester prodrugs are prepared in similar fashion using ethanol in place of methanol.

N,N-diethylglycolamido ester prodrugs may be prepared by reaction of the sodium salt of a compound of Formula (I) (in a medium such as dimethylformamide) with 2-chloro-N,N-diethylacetamide (available from Aldrich Chemical Co., Milwaukee, Wisconsin USA; Item No. 25,099-6).

Morpholinylethyl ester prodrugs may be prepared by reaction of the sodium salt of a compound of Formula (I) (in a medium such as dimethylformamide) 4-(2-chloroethyl)morpholine hydrochloride (available from Aldrich Chemical Co., Milwaukee, Wisconsin USA, Item No. C4,220-3).

Preferred LTB_4 compounds and anti-cancer compounds of the compositions of the wherein the acid, salt and prodrug derivatives thereof are respectively selected from: carboxylic acid, sodium salt, and ester prodrug.

The compositions of the present invention are a combination of therapeutically effective amounts of the leukotriene (LTB_4) antagonists, noted above, and a

therapeutically effective amount of the anti-cancer agents noted above. The composition may be formulated with common excipients, diluents or carriers, and compressed into tablets, or formulated elixirs or solutions for convenient oral administration or administered by intramuscular intravenous routes. The compounds can be administered transdermally and maybe formulated as sustained relief dosage forms and the like.

In another embodiment, the invention relates to a method of treating a patient suffering from a non-multi drug resistant cancerous condition which comprises the separate administration of a therapeutically effective amount of the leukotriene (LTB_4) antagonists, and the anti-cancer agent. When administered separately, the leukotriene (LTB_4) antagonists, and the anti-cancer agent may be administered on a different schedule. One may be administered before the other as long as the time between the two administrations falls within a therapeutically effective interval. Therapeutically effective interval is a period of time beginning when one of either (a) the leukotriene (LTB_4) antagonist or (b) the anti-cancer agent is administered to a human and ending at the limit of the beneficial effect in the treatment of cancer of the combination of (a) and (b). The methods of administration of the leukotriene LTB_4 antagonist and the anti-cancer agent may vary. Thus, one agent may be administered orally, while the other is administered intravenously. It is possible that one of the products may be administered as a continuous infusion while the other is provided in discreet dosage forms. It is particularly important that the anti-cancer drug be given in the manner known to optimize its performance.

Pharmaceutical Compositions of the Invention

Preferably compounds of the invention or pharmaceutical formulations containing these compounds are in unit dosage form for administration to a mammal. The unit dosage form can be a capsule, an IV bag, a tablet, or a vial. The quantity of Active Ingredient in a unit dose of composition is a therapeutically effective amount and may be varied according to the particular treatment involved. It may be appreciated that it may be necessary to make routine variations to the dosage depending on the age and condition of the patient. The dosage will also depend on the route of administration.

The compound can be administered by a variety of routes including oral, aerosol, rectal, transdermal, subcutaneous, intravenous, intramuscular, and intranasal.

Pharmaceutical formulations of the invention are prepared by combining (e.g., mixing) a therapeutically effective amount of the anti-cancer agent (e.g., a 2',2'-difluoronucleoside and an LTB_4 antagonist, such as the compound of Formula A, Formula I, II) together with a pharmaceutically acceptable carrier or diluent therefor. The present pharmaceutical formulations are prepared by known procedures using well known and readily available ingredients.

In making the compositions of the present invention, the Active Ingredient will usually be admixed with a

carrier, or diluted by a carrier, or enclosed within a carrier which may be in the form of a capsule, sachet, paper or other container. When the carrier serves as a diluent, it may be a solid, lyophilzed solid or paste, semi-solid, or liquid material which acts as a vehicle, or can be in the form of tablets, pills, powders, lozenges, elixirs, suspensions, emulsions, solutions, syrups, injectable liquids, aerosols (as a solid or in a liquid medium), or ointment, containing, for example, up to 10% by weight of the active compound. The compounds of the present invention are preferably formulated prior to administration.

For the pharmaceutical formulations any suitable carrier known in the art can be used. In such a formulation, the carrier may be a solid, liquid, or mixture of a solid and a liquid. For example, for intravenous injection the compounds of the invention may be dissolved in sterile water, sterile saline, or sterile water or saline containing sugars and/or buffers at a concentration of about 0.05 to about 5.0 mg/ml in a 4% dextrose/0.5% Na citrate aqueous solution.

Solid form formulations include powders, tablets and capsules. A solid carrier can be one or more substances which may also act as flavoring agents, lubricants, solubilisers, suspending agents, binders, tablet disintegrating agents and encapsulating material.

Tablets for oral administration may contain suitable excipients such as calcium carbonate, sodium carbonate, lactose, calcium phosphate, together with disintegrating

agents, such as maize, starch, or alginic acid, and/or binding agents, for example, gelatin or acacia, and lubricating agents such as magnesium stearate, stearic acid, or talc.

In powders the carrier is a finely divided solid which is in admixture with the finely divided Active Ingredient. In tablets the Active Ingredient is mixed with a carrier having the necessary binding properties in suitable proportions and compacted in the shape and size desired.

Advantageously, compositions containing the compound of Formula (I) may be provided in dosage unit form, preferably each dosage unit containing from about 5 to about 500 mg (from about 5 to 50 mg in the case of parenteral or inhalation administration, and from about 25 to 500 mg in the case of oral or rectal administration. 0.5 to 20 mg/kg, of Active Ingredient may be administered although it will, of course, readily be understood that Dosages from about 0.5 to about 300 mg/kg per day, preferably the amount of the compound or compounds of Formula I actually to be administered will be determined by a physician, in the light of all the relevant circumstances.

Powders and tablets preferably contain from about 1 to about 99 weight percent of the Active Ingredient which is the novel compound of this invention. Suitable solid carriers are magnesium carbonate, magnesium stearate, talc, sugar lactose, pectin, dextrin, starch, gelatin, tragacanth, methyl cellulose, sodium carboxymethyl cellulose, low melting waxes, and cocoa butter.

Sterile liquid form formulations include suspensions, emulsions, syrups and elixirs.

The Active Ingredient can be dissolved or suspended in a pharmaceutically acceptable carrier, such as sterile water, sterile organic solvent or a mixture of both. By "pharmaceutically acceptable" it is meant the carrier, diluent or excipient must be compatible with the other ingredients of the formulation and not deleterious to the recipient thereof.

The Active Ingredient can also be dissolved in a suitable organic solvent, for instance aqueous propylene glycol. Other compositions can be made by dispersing the finely divided Active Ingredient in aqueous starch or sodium carboxymethyl cellulose solution or in a suitable oil.

The following pharmaceutical formulations 1 to 22 are illustrative only and are not intended to limit the scope of the invention in any way. "Active Ingredient", refers to a 2',2'-difluoronucleoside or a compound according to Formula A, Formula (I) or (II) or a pharmaceutically acceptable salt, solvate, or prodrug thereof.

In one embodiment the compositions of the present invention are a combination of therapeutically effective amounts of the leukotriene (LTB_4) antagonists, noted above, and a therapeutically effective amount of a 2',2'-difluoronucleoside anti-cancer agent. The composition may be formulated with common excipients, diluents or carriers, and compressed into tablets, or formulated elixirs or

solutions for convenient oral administration or administered by intramuscular intravenous routes. The compounds can be administered transdermally and maybe formulated as sustained relief dosage forms and the like.

In another embodiment, the 2',2'-difluoronucleoside anti-cancer agents are formulated independently of the leukotrienes (LTB_4) antagonists and are administered separately. The anti-cancer agents may be formulated with common excipients, diluents or carriers and administered by intravenous infusion. On the other hand, the anti-cancer agents may be formulated into liquids suitable for oral administration. Anti-cancer agents may also be compressed into tablets and administered orally. If the anti-cancer agents and the leukotrienes (LTB_4) antagonists are administered separately, the anti-cancer agents may be administered before, after or during the administration of the leukotriene (LTB_4) antagonists. If the anti-cancer agents are administered separately from the leukotrienes (LTB_4) antagonists, they must be administered within a therapeutically effective interval.

The method of treating a human patient according to the present invention includes both the administration of the combination of leukotriene (LTB_4) antagonists and an anti-cancer agent as well as the separate administration of the leukotriene (LTB_4) antagonists and the anti-cancer agent. When administered separately, the leukotriene (LTB_4) antagonists are formulated into formulations which may be administered by the oral and rectal routes, topically, parenterally, e.g., by injection and by continuous or discontinuous intra-arterial infusion, in the form of, for

example, tablets, lozenges, sublingual tablets, sachets, cachets, elixirs, gels, suspensions, aerosols, ointments, for example, containing from 1 to 10% by weight of the active compound in a suitable base, soft and hard gelatin capsules, suppositories, injectable solutions and suspensions in physiologically acceptable media, and sterile packaged powders adsorbed onto a support material for making injectable solutions. Advantageously for this purpose, compositions may be provided in dosage unit form, preferably each dosage unit containing from about 5 to about 500 mg (from about 5 to 50 mg in the case of parenteral or inhalation administration, and from about 25 to 500 mg in the case of oral or rectal administration) of a compound of Formula I or Formula II. Dosages from about 0.5 to about 300 mg/kg per day, preferably 0.5 to 20 mg/kg, of active ingredient may be administered although it will, of course, readily be understood that the amount of the compound or compounds of Formula I actually to be administered will be determined by a physician, in the light of all the relevant circumstances including the condition to be treated, the choice of compound to be administered and the choice of route of administration and therefore the above preferred dosage range is not intended to limit the scope of the present invention in any way.

The formulations useful for separate administration of the leukotriene (LTB_4) antagonists will normally consist of at least one compound selected from the compounds of Formula A and Formula I mixed with a carrier, or diluted by a carrier, or enclosed or encapsulated by an ingestible carrier in the form of a capsule, sachet, cachet, paper or other container or by a disposable container such as an

ampoule. A carrier or diluent may be a solid, semi-solid or liquid material which serves as a vehicle, excipient or medium for the active therapeutic substance. Some examples of the diluents or carrier which may be employed in the pharmaceutical compositions of the present invention are lactose, dextrose, sucrose, sorbitol, mannitol, propylene glycol, liquid paraffin, white soft paraffin; kaolin, fumed silicon dioxide, microcrystalline cellulose, calcium silicate, silica, polyvinylpyrrolidone, cetostearyl alcohol, starch, modified starches, gum acacia, calcium phosphate, cocoa butter, ethoxylated esters, oil of theobroma, arachis oil, alginates, tragacanth, gelatin, syrup, methyl cellulose, polyoxyethylene sorbitan monolaurate, ethyl lactate, methyl and propyl hydroxybenzoate, sorbitan trioleate, sorbitan sesquioleate and oleyl alcohol and propellants such as trichloromonofluoromethane, dichlorodifluoromethane and dichlorotetrafluoroethane. In the case of tablets, a lubricant may be incorporated to prevent sticking and binding of the powdered ingredients in the dies and on the punch of the tableting machine. For such purpose there may be employed for instance aluminum, magnesium or calcium stearates, talc or mineral oil.

Preferred pharmaceutical forms of the present invention are capsules, tablets, suppositories, injectable solutions, creams and ointments. Especially preferred are formulations for inhalation application, such as an aerosol, and for oral ingestion.

The following formulation examples may employ as active compounds any of the leukotriene (LTB_4) antagonists noted

above. The examples are illustrative only and are not intended to limit the scope of the invention in any way.

FORMULATION EXAMPLE 1

Hard gelatin capsules are prepared using the following ingredients:

	Quantity (mg/capsule)
3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-carboxy-phenoxy)phenyl)propanoic acid	250
Starch	200
Magnesium stearate	10

The above ingredients are mixed and filled into hard gelatin capsules in 460 mg quantities.

FORMULATION EXAMPLE 2

A tablet is prepared using the ingredients below:

	Quantity (mg/capsule)
1-(4-(Carboxymethoxy)phenyl)-1-(1H-tetrazol-5-yl)-6-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)hexane	250
Cellulose, microcrystalline	400
Silicon dioxide, fumed	10
Magnesium stearate	5

The components are blended and compressed to form tablets each weighing 665 mg.

FORMULATION EXAMPLE 3

An aerosol solution is prepared containing the following components:

	Weight %
3-[4-[7-Carboxy-9-oxo-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]-9H-xanthene]]propanoic acid	0.25
Ethanol	30.00
Propellant 11 (trichlorofluoromethane)	10.25
Propellant 12 (Dichlorodifluoromethane)	29.75
Propellant 114 (Dichlorotetrafluoroethane)	29.75

The active compound is dissolved in the ethanol and the solution is added to the propellant 11, cooled to -30°C. and transferred to a filling device. The required amount is then fed to a container and further filled with the pre-mixed propellants 12 and 114 by means of the cold-filled method or pressure-filled method. The valve units are then fitted to the container.

FORMULATION EXAMPLE 4

Tablets each containing 60 mg of active ingredient are made up as follows:

2-[2-Propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]-benzoic acid sodium salt	60 mg
Starch	45 mg
Microcrystalline cellulose	35 mg
Polyvinylpyrrolidone (as 10% solution in water)	4 mg
Sodium carboxymethyl starch	4.5 mg
Magnesium stearate	0.5 mg
Talc	1 mg
Total	150 mg

The active ingredient, starch and cellulose are passed through a No. 45 mesh U.S. sieve (355 μm) and mixed thoroughly. The solution of polyvinylpyrrolidone is mixed with the resultant powders which are then passed through a No. 14 mesh U.S. sieve (1.4 mm). The granules so produced are dried at 50-60° and passed through a No. 18 mesh U.S. sieve (1.00 mm). The sodium carboxymethyl starch, magnesium stearate and talc, previously passed through a No. 60 mesh U.S. sieve (250 μm), are then added to the granules which, after mixing, are compressed on a tablet machine to yield tablets each weighing 150 mg.

FORMULATION EXAMPLE 5

Capsules each containing 80 mg of medicament are made as follows:

5-[3-[2-(1-Carboxy)ethyl]-4-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]-phenyl]-4-pentynoic acid	80 mg
Starch	59 mg
Microcrystalline cellulose	59 mg
Magnesium stearate	2 mg
Total	200 mg

The active ingredient, cellulose, starch and magnesium stearate are blended, passed through a No. 45 mesh U.S. sieve (355 μm), and filled into hard gelatin capsules in 200 mg quantities.

FORMULATION EXAMPLE 6

Suppositories each containing 225 mg of active ingredient are made as follows:

3-(5-(6-(4-(4-Fluorophenyl)-5-hydroxy-2-ethylphenoxy)propoxy)-2-carboxymethyl-1,2,3,4-tetrahydronaphthalen-1(2H)-one)propanoic acid	225 mg
Unsaturated or saturated fatty acid glycerides to	2,000 mg

The active ingredient is passed through a No. 60 mesh U.S. sieve (250 μm) and suspended in the fatty acid glycerides previously melted using the minimum heat necessary. The mixture is then poured into a suppository mold of nominal 2 g capacity and allowed to cool.

FORMULATION EXAMPLE 7

Suspensions each containing 50 mg of medicament per 5 mL dose are made as follows:

2-[2-Propyl-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]phenoxy]benzoic acid	50 mg
Sodium carboxymethyl cellulose	50 mg
Sugar	1 g
Methyl paraben	0.05 mg
Propyl paraben	0.03 mg
Flavor	q.v.
Color	q.v.
Purified water to	5 mL

The medicament is passed through a No. 45 mesh U.S. sieve (355 μm) and mixed with the sodium carboxymethylcellulose, sugar, and a portion of the water to form a suspension. The parabens, flavor and color are dissolved and diluted with some of the water and added, with

stirring. Sufficient water is then added to produce the required volume.

FORMULATION EXAMPLE 8

Hard gelatin capsules are prepared using the following ingredients:

	Quantity (mg/capsule)
1-(4-amino-5-methyl-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluororibose	250
Starch dried	200
Magnesium stearate	10

The above ingredients are mixed and filled into hard gelatin capsules in 460 mg quantities.

FORMULATION EXAMPLE 9

A tablet formula is prepared using the ingredients below:

	Quantity (mg/tablet)
1-(2-oxo-4-amino-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluoro-ribose	250
Cellulose, microcrystalline	400
Silicon dioxide, fumed	10
Stearic acid	5

The components are blended and compressed to form tablets each weighing 665 mg.

FORMULATION EXAMPLE 10

An aerosol solution is prepared containing the following components:

	Weight %
1-(2,4-dioxo-1H,3H-pyrimidin-1-yl)-2-desoxy-2',2'-difluoro-ribose	0.25
Ethanol	29.75
Propellant 22 (Chlorodifluoromethane)	70.00

The active compound is mixed with ethanol and the mixture added to a portion of the propellant 22, cooled to -

30.degree. C. and transferred to a filling device. The required amount is then placed in a stainless steel container and diluted with the remainder of the propellant. The valve units are then fitted to the container.

FORMULATION EXAMPLE 11

Tablets each containing 60 mg of active ingredient are made up as follows:

1-(4-amino-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluoro-ribose	60	mg
Starch	45	mg
Microcrystalline cellulose	35	mg
Polyvinylpyrrolidone (as 10% solution in water)	4	mg
Sodium carboxymethyl starch	4.5	mg
Magnesium stearate	0.5	mg
Talc	1	mg

The difluoronucleoside starch and cellulose are passed through a No. 45 mesh U.S. sieve and mixed thoroughly. The solution of polyvinylpyrrolidone is mixed with the resultant powders which are then passed through a No. 14 mesh U.S. sieve. The granules so produced are dried at 50.degree.-60.degree. C. and passed through a No. 18 mesh U.S. sieve. The sodium carboxymethyl starch, magnesium stearate and talc, previously passed through a No. 60 mesh U.S. sieve,

are then added to the granules which, after mixing, are compressed on a tablet machine to yield tablets each weighing 150 mg.

FORMULATION EXAMPLE 12

Capsules each containing 80 mg of medicament are made as follows:

1-(4-amino-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluor-oxylose	80 mg
Starch	59 mg
Microcrystalline cellulose	59 mg
Magnesium stearate	2 mg

The active ingredient, cellulose, starch and magnesium stearate are blended, passed through a No. 45 mesh U.S. sieve, and filled into hard gelatin capsules in 200 mg quantities.

FORMULATION EXAMPLE 13

Suppositories each containing 225 mg of nucleoside are made as follows:

1-(2,4-dioxo-1H,3H-pyrimidin-1-yl)-2-desoxy-2',2'-difluoro-ribose	225 mg
Saturated fatty acid glycerides to	2 g

The nucleoside is passed through a No. 60 mesh U.S. sieve and suspended in the saturated fatty acid glycerides previously melted using the minimum heat necessary. The mixture is then poured into a suppository mold of nominal 2 g capacity and allowed to cool.

FORMULATON EXAMPLE 14

Suspensions each containing 50 mg of medicament per 5 ml dose are made as follows:

1-(4-amino-5-methyl-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluororibose	50	mg
Sodium carboxymethyl Cellulose	50	mg
Syrup	1.25	ml
Benzoic acid solution	0.10	ml
Flavor		q.v.
Color		q.v.
Purified water to	5.	ml

FORMULATION EXAMPLE 15

An intravenous formulation is prepared as follows:

1-(4-amino-2-oxo-1H-pyrimidin-1-yl)-2-desoxy-2',2'-difluoro ribose	100	mg
isotonic saline	1000	ml

The solution of the above ingredients is administered intravenously at a rate of 1 ml/minute to a mammal in need of treatment from susceptible neoplasms.

FORMULATION EXAMPLE 16

Hard gelatin capsules are prepared using the following ingredients:

	Quantity (mg/capsule)
3-(2-(3-(2-Ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)propoxy)-6-(4-carboxy-phenoxy)phenyl)propanoic acid	250
2',2'-Diflouro-2'-deoxycytidine monohydrochloride	250
Starch	200
Magnesium stearate	10

The above ingredients are mixed and filled into hard gelatin capsules in 710mg quantities.

FORMULATION EXAMPLE 17

A tablet is prepared using the ingredients below:

	Quantity (mg/capsule)
1-(4-(Carboxymethoxy)phenyl)-1-(1H-tetrazol-5-yl)-6-(2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy)hexane	250
2',2'-Difluoro-2'-deoxycytidine monochloride	250
Cellulose, microcrystalline	400
Silicon dioxide, fumed	10
Magnesium stearate	5

The components are blended and compressed to form tablets each weighing 915 mg.

FORMULATION EXAMPLE 18

An aerosol solution is prepared containing the following components:

	Weight %
3-[4-[7-Carboxy-9-oxo-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]-9H-xanthene]]propanoic acid	0.25
2',2'-difluoro-2'-deoxycytidine monohydrochloride	0.25
Ethanol	30.00
Propellant 11 (trichlorofluoromethane)	10.00
Propellant 12 (Dichlorodifluoromethane)	29.75
Propellant 114 (Dichlorotetrafluoroethane)	29.75

The active compound is dissolved in the ethanol and the solution is added to the propellant 11, cooled to -30°C. and transferred to a filling device. The required amount is then fed to a container and further filled with the pre-mixed propellants 12 and 114 by means of the cold-filled method or pressure-filled method. The valve units are then fitted to the container.

FORMULATION EXAMPLE 19

Tablets each containing 60 mg of active ingredient are made up as follows:

2-[2-Propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]-benzoic acid sodium salt	60 mg
2',2'-difluoro-2'deoxycytidine monohydrochloride	60 mg
Starch	45 mg
Microcrystalline cellulose	35 mg
Polyvinylpyrrolidone (as 10% solution in water)	4 mg
Sodium carboxymethyl starch	4.5 mg
Magnesium stearate	0.5 mg
Talc	1 mg
Total	210 mg

The active ingredient, starch and cellulose are passed through a No. 45 mesh U.S. sieve (355 μm) and mixed thoroughly. The solution of polyvinylpyrrolidone is mixed with the resultant powders which are then passed through a No. 14 mesh U.S. sieve (1.4 mm). The granules so produced are dried at 50-60° and passed through a No. 18 mesh U.S. sieve (1.00 mm). The sodium carboxymethyl starch, magnesium stearate and talc, previously passed through a No. 60 mesh U.S. sieve (250 μm), are then added to the granules which,

after mixing, are compressed on a tablet machine to yield tablets each weighing 210 mg.

FORMULATION EXAMPLE 20

Capsules each containing 80 mg of medicament are made as follows:

5-[3-[2-(1-Carboxy)ethyl]-4-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]-phenyl]-4-pentynoic acid	80 mg
2',2'-difluoro-2'deoxycytidine monohydrochloride	80 mg
Starch	59 mg
Microcrystalline cellulose	59 mg
Magnesium stearate	2 mg
Total	280 mg

The active ingredient, cellulose, starch and magnesium stearate are blended, passed through a No. 45 mesh U.S. sieve (355 μm), and filled into hard gelatin capsules in 280 mg quantities.

FORMULATION EXAMPLE 21

Suppositories each containing 225 mg of active ingredient are made as follows:

3-(5-(6-(4-(4-Fluorophenyl)-5-hydroxy-2-ethylphenoxy)propoxy)-2-carboxymethyl-1,2,3,4-tetrahydronaphthalen-1(2H)-one)propanoic acid	225 mg
2',2'-difluoro-2'-deoxycytidine monochloride	225 mg
Unsaturated or saturated fatty acid glycerides to	2,000 mg

The active ingredient is passed through a No. 60 mesh U.S. sieve (250 μm) and suspended in the fatty acid glycerides previously melted using the minimum heat necessary. The mixture is then poured into a suppository mold of nominal 2 g capacity and allowed to cool.

FORMULATION EXAMPLE 22

Suspensions each containing 50 mg of medicament per 5 mL dose are made as follows:

2-[2-Propyl-3-[3-[2-ethyl-4-(4-fluorophenyl)-5-hydroxyphenoxy]propoxy]phenoxy]benzoic acid	50 mg
2',2'-difluoro-2'-deoxycytidine monohydrochloride	50 mg
Sodium carboxymethyl cellulose	50 mg
Sugar	1 g
Methyl paraben	0.05 mg
Propyl paraben	0.03 mg
Flavor	q.v.
Color	q.v.
Purified water to	5 mL

The medicament is passed through a No. 45 mesh U.S. sieve (355 μm) and mixed with the sodium carboxymethylcellulose, sugar, and a portion of the water to form a suspension. The parabens, flavor and color are dissolved and diluted with some of the water and added, with stirring. Sufficient water is then added to produce the required volume.

Pharmaceutical Compositions of the Invention

The pharmaceutical composition of the invention comprises as essential ingredients:

(a) an LTB_4 antagonist, and

(b) an anti-cancer agent.

When the pharmaceutical composition of the invention is prepared in injectable form it is a composition comprising as ingredients:

(a) an LTB_4 antagonist,

(b) an anti-cancer agent, and

(c) an injectable liquid carrier.

Pharmaceutically acceptable carriers are those well known in the medical arts, such as sterile water, sterile water containing saline, and sterile water containing sugars and/or saline.

atio and Amount of Ingredients in the Composition of the Invention

The essential ingredients (a) an LTB_4 antagonist and (b) anti-cancer compound are present in the formulation in such proportion that a dose of the formulation provides a pharmaceutically effective amount of each ingredient to the patient being treated. Typically, the weight ratio of LTB_4 antagonist to anti-cancer agent 1:100 to 100 to 1, preferable from 10:1 to 1:10 and most preferable from 1:4 to 4:1.

The leukotriene (LTB_4) antagonists are generally administered prior, during and after the 2',2'-difluoronucleoside anti-cancer agent is administered. If the leukotriene (LTB_4) antagonists are administered after

the 2',2'-difluoronucleoside anti-cancer agent they should be administered within a therapeutically effective interval.

ASSAY EXAMPLE 1

The Nude Mouse Xenograft test used to evaluate anti-oncolytic agents of this invention is well known and generally described in the textbook; Beverly A Teicher, Editor, Anticancer Drug Development Guide, Humana Press, Totowa, New Jersey, 1997, p.75-124 (ISBN 0-89603-461-5); the disclosure of which is incorporated herein by reference. The xenograft test is more particularly described as follows:

Male or female nude mice, selected as appropriate to the gender of the tumor (Charles River), were treated with total body *gamma* Radiation (450 rads). After 24 hours, human LNCaP and DU-145 prostate carcinomas, Panc-1 and BxPC-3 pancreatic carcinomas, and H460 and Calu-6 non-small cell lung carcinomas (all carcinomas available from American Type Culture Collection, Manassas, VA) prepared from a brie of donor tumors (5 x 10^6 cells) were implanted subcutaneously in a hind-leg of the mice. The mice were treated with 2-[2-propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy] benzoic acid (Formula IV), at dosages of 30, 100, 200, or 300 mg per kilogram daily, administered orally, beginning 4 days after the tumor cell implantation. Gemcitabine (60 mg/kg) was administered intraperitoneally.

Tumor response was monitored by tumor volume measurement performed twice per week over the course of 60-90 days. Body weights were determined as a general measurement of toxicity. The mice were divided into an

untreated control group and multiple treatment groups with five mice in each group.

The data was analyzed by determining the mean tumor volume for the control group and each treatment group over the course of the experiment and calculated the tumor growth delay as the difference in days for the treatment versus the control tumors to reach the volume of 1000 mm^3.

Table 1

Mouse Xenograft Test Results

Growth Delay of Prostate Tumor(1)

Treatment	dose Formula IV	dose GEM	TGD	TGD, sem
Formula IV	30	-	1.2	0.30
Formula IV	100	-	2.0	0.30
Formula IV	200	-	2.2	0.30
GEM	-	60	12.2	0.50
Formula IV + GEM	30	60	43.2	3.00
Formula IV + GEM	100	60	51.2	3.50

(1) = LNCaP prostate carcinoma

Formula IV = the LTB_4 antagonist, 2-[2-propyl-3-[3-[2-ethyl-5-hydroxy-4-(4-fluorophenyl)phenoxy]propoxy]phenoxy]benzoic acid

GEM = gemcitabine hydrochloride, a 2',2'-difloronucleoside anti-cancer agent, product of Eli Lilly and Company

LNCaP = LNCaP Prostate Carcinoma

dose = milligrams per kilogram mouse body weight

TGD = average tumor growth delay in days

sem = standard error of the mean

Table 2

Mouse Xenograft Test Results

Growth Delay of Prostate Tumor(2)

Treatment	dose Formula IV	dose GEM	TGD	TGD, sem
Formula IV	30	-	5.8	0.50
Formula IV	100	-	7.7	0.60
Formula IV	300	-	12.7	1.00
GEM	-	60	9.6	0.80
Formula IV + GEM	30	60	15.6	1.40
Formula IV + GEM	100	60	25.2	2.20

(2) = DU-145 prostate carcinoma

Table 3

Mouse Xenograft Test Results

Growth Delay of Pancreatic Tumor(3)

Treatment	dose Formula IV	dose GEM	TGD	TGD, sem
Formula IV	30	-	7.4	0.50
Formula IV	100	-	21.6	2.00
Formula IV	300	-	30.2	3.20
GEM	-	60	17.1	1.50
Formula IV + GEM	30	60	22.9	1.90
Formula IV + GEM	100	60	27.0	2.30

(3) = tumor is BxPC3 pancreatic cancer

Table 4

Mouse Xenograft Test Results

Growth Delay of Pancreatic Tumor[4]

Treatment	dose Formula IV	dose GEM	TGD	TGD, sem
Formula IV	30	-	10.2	1.40
Formula IV	100	-	16.7	2.00
Formula IV	200	-	19.4	2.40
GEM	-	60	7.70	0.80
Formula IV + GEM	30	60	18.2	1.50
Formula IV + GEM	100	60	23.3	2.30
Formula IV + GEM	200	60	29.1	3.00

(4) = tumor is Panc-1 pancreatic cancer

Table 5

Mouse Xenograft Test Results

Growth Delay of non-Small cell Lung Tumor(5)

Treatment	dose Formula IV	dose GEM	TGD	TGD, sem
Formula IV	30	-	10.9	1.00
Formula IV	100	-	13.2	1.20
Formula IV	200	-	13.9	1.30
GEM	-	60	9.3	0.90
Formula IV + GEM	30	60	20.2	2.00
Formula IV + GEM	100	60	21.3	2.20
Formula IV + GEM	200	60	32.0	3.10

(5) = non-Small cell Lung tumor is Human H460 NSCLC

Table 6

Mouse Xenograft Test Results

Growth Delay of non-Small cell Lung Tumor(6)

Treatment	dose Formula IV	dose GEM	TGD	TGD, sem
Formula IV	30	-	7.4	0.60
Formula IV	100	-	10.0	0.80
Formula IV	200	-	17.9	1.60
GEM	-	60	14.0	1.20
Formula IV + GEM	30	60	17.4	1.60
Formula IV + GEM	100	60	22.5	2.00

(6) = non-Small cell Lung tumor is Calu-6 carcinoma

Detailed Description of the Drawings:

Figures 1 thru 6 in the Drawings display the data in the Tables 1 thru 6, supra. The Figures illustrate the increased effectiveness of a combination treatment of (i) Formula IV and (ii) gemcitabine hydrochloride in delaying tumor growth over use of the individual agents (i) or (ii).

Fig. 1 - displays various treatments for LNCaP prostate carcinoma.

Bars (1), (2), and (3) display tumor growth delay resulting from use of LTB_4 inhibitor, Formula IV, alone at doses of 30, 100, and 200 mg/kg, respectively.

Bar (4) displays tumor growth delay for the anti-cancer agent, gemcitabine hydrochloride, alone at a dose of 60 mg/kg.

Bars (5) and (6) display tumor growth delay resulting from combined use of Formula IV (at doses of 30 and 100 mg/kg) and gemcitabine hydrochloride (at a dose of 60 mg/kg); respectively.

Fig. 2 - displays various treatments for DU-145 prostate carcinoma.

Bars (1), (2), and (3) display tumor growth delay resulting from use of LTB_4 inhibitor, Formula IV, alone at doses of 30, 100, and 300 mg/kg, respectively.

Bar (4) display tumor growth delay for the anti-cancer agent, gemcitabine hydrochloride, alone at a dose of 60 mg/kg.

Bars (5) and (6) display tumor growth delay resulting from combined use of Formula IV (at doses of 30 and 100 mg/kg) and gemcitabine hydrochloride (at a dose of 60 mg/kg); respectively.

Fig. 3 - displays various treatments for BxPC3 pancreatic carcinoma.

Bars (1), (2), and (3) display tumor growth delay resulting from use of LTB_4 inhibitor, Formula IV, alone at doses of 30, 100, and 300 mg/kg, respectively.

Bar (4) display tumor growth delay for the anti-cancer agent, gemcitabine hydrochloride, alone at a dose of 60 mg/kg.

Bars (5) and (6) display tumor growth delay resulting from combined use of Formula IV (at doses of 30 and 100 mg/kg) and gemcitabine hydrochloride (at a dose of 60 mg/kg); respectively.

Fig. 4 - displays various treatments for Panc-1 pancreatic carcinoma.

Bars (1), (2), and (3) display tumor growth delay resulting from use of LTB_4 inhibitor, Formula IV, alone at doses of 30, 100, and 200 mg/kg, respectively.

Bar (4) display tumor growth delay for the anti-cancer agent, gemcitabine hydrochloride, alone at a dose of 60 mg/kg.

Bars (5), (6) and (7) display tumor growth delay resulting from combined use of Formula IV (at doses of 30, 100 and 200 mg/kg) and gemcitabine hydrochloride (at a dose of 60 mg/kg); respectively.

Fig. 5 - displays various treatments for Human H460 non-Small cell Lung carcinoma.

Bars (1), (2), and (3) display tumor growth delay resulting from use of LTB_4 inhibitor, Formula IV, alone at doses of 30, 100, and 200 mg/kg, respectively.

Bar (4) display tumor growth delay for the anti-cancer agent, gemcitabine hydrochloride, alone at a dose of 60 mg/kg.

Bars (5),(6) and (7) display tumor growth delay resulting from combined use of Formula IV (at doses of 30, 100 and 200 mg/kg) and gemcitabine hydrochloride (at a dose of 60 mg/kg); respectively.

Fig. 6 - displays various treatments for Calu-6 non-small cell Lung carcinoma.

Bars (1), (2), and (3) display tumor growth delay resulting from use of LTB_4 inhibitor, Formula IV, alone at doses of 30, 100 and 200 mg/kg, respectively.

Bar (4) display tumor growth delay for the anti-cancer agent, gemcitabine hydrochloride, alone at a dose of 60 mg/kg.

Bars (5) and (6) display tumor growth delay resulting from combined use of Formula IV (at doses of 30 and 100 mg/kg) and gemcitabine hydrochloride (at a dose of 60 mg/kg); respectively.